What is the impact of higher minimum wage rates on the employment of teenagers in the United States?

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I. Introduction

We want to find out how the minimum wage increase in the United States nourishes the teenage employment rate. First, we can predict this through theoretical and logical economic knowledge, not empirical knowledge through surveys and surveys. We must first consider the relationship between the Consumer Price Index (CPI) and the minimum wage. Over time, the minimum wage is bound to rise numerically and naturally. This is because there is a "time value of money" theory that even the same amount of money is worth more than future money. In addition, the Consumer Price Index (CPI) continues to grow over time due to the government's increase in currency issuance (supply), rising raw material prices of goods, and imbalance between consumption and supply. Therefore, as the consumer price index rises, the minimum wage also naturally increases. For example, if we could buy an apple for a dollar 10 years ago, we can now buy an apple of the same quality for two dollars. But if the minimum wage remains unchanged from 10 years ago and now, workers will have a hard time living and many will not do it anymore. That makes it difficult for employers to find people to work. Therefore, if consumer prices rise, the minimum wage will inevitably rise in line with prices. At this time, we should therefore consider the 'real minimum wedge' that excludes the effect of CPI rise in the minimum wedge. Suppose that the minimum wage has risen significantly in a year by government policy, although the CPI has risen little compared to last year. This is the case where the real minimum wage has risen. If the same intensity of labor and working hours are guaranteed, workers will be paid more than last year. However, for employers, it is a big burden to pay a lot of labor costs. Therefore, there are three main solutions for employers. There are ways to increase the employment intensity of workers, reduce the number of employees themselves, or reduce the number of employees while reducing the number of employees so that workers can produce more. In the data we have, we can look at the change in the number

of employees and the change in the working hours of workers according to the higher real minimum measure. We can hypothesize on these two issues. As the real minimum wage increases, the number of employees in their teens will decrease, and the working hours type will increase the proportion of part time. In the background of this hypothesis, there is a key basis that employees prefer professional manpower as the real minimum wage increases. Since work efficiency should be maximized while minimizing labor costs, the proportion of employers or managers, who are professionals, will increase rather than requiring workers to work full-time. From the employer's point of view, there is no need to pay workers with poor work efficiency while teaching them their own work. The standard of work efficiency varies depending on the type of work, but it can mainly vary depending on educational background, gender, and race. Therefore, the overall number of teenage workers will decrease, and the working time type will decrease the proportion of full time and the proportion of part time will increase. In addition, the rise in the minimum wage can affect the ratio of educational background, gender, and race of teenage workers overall. In the next section, we will review literature that has been analyzed through actual data rather than predictions based on theoretical economic knowledge.

- **Difference of T-test and F-test**

In statistics, the analysis methods that can be used for group comparison are Z-test, T-test, and F-test. Among them, the analysis method of comparing the average of two groups is called Z-test and T-test. Z-test is a method used when the variance of a population is known in advance or when the sample size is more than 30, but the variance is rarely known, so T-test is mainly used. In addition, if the sample size is greater than 30, the normal distribution can be assumed according to the central limit theorem, even if the variance of the population is unknown, resulting in almost the same result between the T-test and the Z-test. Therefore, a T-test that

can be used even if the sample size is less than or equal to 30 is mainly used. As mentioned above, the T-test is an analysis method that tests the average difference between two independent sample groups, that is, a method for comparing differences according to two variables, such as men and women. The analysis method used to test whether the mean between the two groups shows statistically significant differences can also be used when an enterprise develops a new product to identify differences in recognition of new products between urban and rural areas.

In this process, a t value appears, where the significance test and the difference test are concluded as p values. When the significance level is 95% (which is the basic level), if the p value is less than .05, the difference is recognized. In other words, it can be said that there is a difference between men and women or between urban and rural areas. However, to obtain a p value, a t value is required, and by obtaining this t value, an appropriate p value can be obtained. Therefore, t and F are called test statistics, and p is called significance probabilities.

F-test. is an analysis method used to compare three or more groups. The key to the F-test is dispersion. In other words, the dispersion of a specific group means how heterogeneous or homogeneous the group is. For example, we can analyze the differences according to the age of the three groups, A, B, and C, where the test statistic is F, not t. It is also a figure to obtain the value of p. When examining the age of the three groups, if the variance of the age of group A is greater than B and C, group A is composed of relatively diverse, that is, heterogeneous age groups compared to group B and C.

For reference, in the regression analysis, T is a statistic on the influence of variables, F is a

suitability of the model, and P is a significant probability as shown above. Regression analysis examines the effect of an independent variable on a dependent variable and checking whether the independent variable has an effect is called the t value and the probability of significance. In addition, F sees the suitability of the ANOVA model, that is, whether the regression model appeared properly. In our project, we will use almost F-test.

II. Review of relevant literature

We will first review previous studies to supplement the hypothesis. First, there is a previous study that analyzed the relationship between the employment rate of teenagers due to the rise in the minimum wage. [*The effect of the minimum wage on employment and unemployment C Brown*], *1982 - C Gilroy, AKOHEN* argues that when the minimum wage increases by 10%, the employment rate of teenagers decreases by up to 3%. [*Employment Effects of Minimum and Subminimum Wages: Panel Data on State Minimum Wages*], *1992 - David Neumark, William Wascher* argues that when the minimum wage increases by 10%, the employment rules for teenagers and young people both decrease by 1 to 3%. However, these are all results of research relatively long ago based on data from the 1980s. Therefore, it may be unreliable to apply our project from 1990 to 2013. On the other hand, [*Do Minimum Wages Really Reduce Teen Employment? Accounting for Heterogenicity and Selectivity in State Panel Data*], *2011 - SYLVIA A. ALLEGRETO, ARINDRAJIT DUBE, MICHAEL RICH*, claims that the U.S. employment rate from 1990 to 2009 is not affected at all. This study is almost consistent with the year range of our analysis target, so it is judged to be more reliable than the above-mentioned two studies. Therefore, we confirmed reliable research results contrary to our hypothesis that the minimum wage increase revealed in the introduction adversely affects the employment rate of teenagers.

Next, there is a previous study that analyzed the relationship between the types of working hours of teenagers according to the rise in the minimum wage. [*The effect of the minimum age on employment and hours*], *2000 - Madeline Zavodny* argues that in the United States, the employment rate of teenagers decreases as the minimum wage rises from 1979 to 1993, but there is no change in working hours. However, this study is not very reliable because there is an error with the year range of our analysis target. However, the introduction confirmed the research results contrary to our hypothesis that the increase in the minimum wage, which is bright, will reduce working hours in teenagers.

As a result of the Literature review, there were some research results that supported our hypothesis, but there were more research results contrary to the hypothesis. Of course, since each study was conducted with different data, the research results may be sufficiently different. However, we could obtain research directions and insights through similar prior research reviews.

III. Data

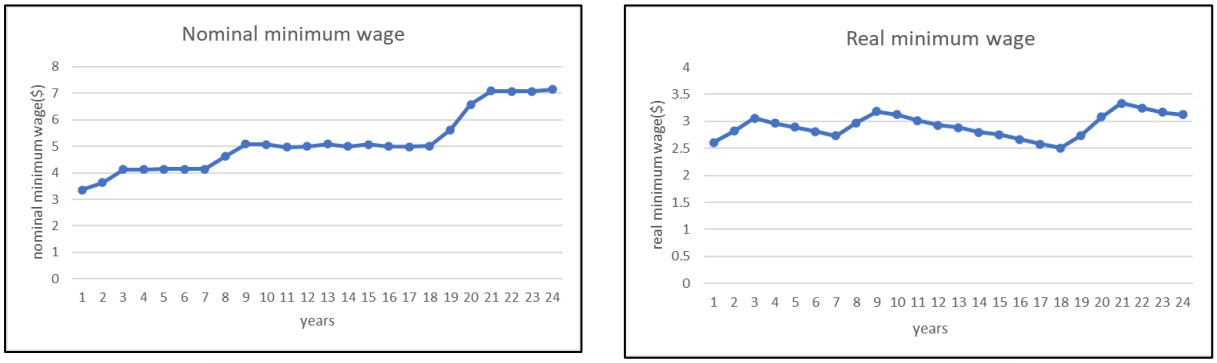
The Current Population Survey (CPS) is a monthly survey of labor market outcomes. March CPS is the data set used to calculate poverty rates for the United States, and survey participants answer questions about labor market outcomes in the previous year. Some of the variables in the survey include questions about whether the respondent is currently employed, how many hours/weeks they work, and what industry they are employed in. Data are aggregated to the state/year cell, and the key variables are the fraction of teens aged 16-19 that are employed as of March. The data span from 1990 to 2013 (24 years) for 50 states and DC for a total of 24*51=1,224 observations. There are 70 employment variables which are a Fraction of teens aged 1-19 that are enrolled in school and fraction of teens aged 16-19 that are employed, part-

time, full-time, retail sector, restaurant, each contains females, males, 16-17 years old, 17-18 years old, white, minorities. Additionally, two variables are added to this data set. One is the Consumer Price Index (CPI) as of March of the year, and the other is the minimum wage that was in effect at the state level in a particular year.

The minimum wage in each state of the United States must be equal to or higher than the federal minimum wage. Therefore, when the federal government raises the minimum wage, most states' minimum wage increases in the same year. As mentioned in the introduction, the minimum wage should increase as the consumer price index CPI increases. Therefore, even if the minimum wage is not designated by the federal government, each state shows a pattern of continuous increases in the minimum wage. At this time, we should derive an adjusted real minimum wedge considering the influence of CPI. The formula of the real minimum wage is simple. Dividing the normal minimum wage by the CPI and multiplying it by 100 for scale adjustment can lead to the real minimum wage. In this way, the effect of increasing the minimum wage due to an increase in CPI (inflation) can be excluded.

$$minwage_{real,t} = \frac{\text{min}wage_{nominal,t}}{CPI_t}$$

The following graph clearly shows the difference between the two indicators.



<fig.1: Nominal minimum wage converts into real minimum wage.>

Normal minimum wages, such as CPI, continue to rise and fall over time, while real minimum

wages continue to rise and fall while the average remains the same. This is proof that the CPI correction is well done. In addition, looking at the two graphs, there have been three significant increases in the state-level minimum wage over a period of 24 years. In future analysis, this real minimum wage will be used instead of the normal minimum wage.

IV. Model

This is panel data (both cross sectional and time series), which can be used for policy analysis with DiD(difference in differences) as special case of fixed effects. However, our data should be analyzed by considering 51 states (group) and 24 years (time period) comprehensively. Therefore, we should use the general framework for policy analysis method instead of the standard DiD model. This model includes multiple control and treatment groups as well as more than two time periods. Additionally, the parallel trends assumption can also be relaxed for multiple time period. In reference to <*The effect of the minimum wage on employment and hours*> - *Madeline Zavodny*, we can set our model as:

$$y_{it} = \beta log(RMW_{it}) + \boldsymbol{\gamma}\, \boldsymbol{Z_{it}} + \psi_i t + \alpha_i + \tau_t + \epsilon_{it}$$

Where "i" subscript is state as cross-sectional data, "t" subscript is year as time series. $employed_{it}$ is the Fraction of teens aged 16-19 that are employed in state i, in year t. We want to find how minimum wage affect to employed ratio. Therefore, we use policy effect as RMW_{it} that real minimum wage in state i, year t. We interest in estimate to coefficient β for result. Additionally, we should use log real minimum wage not an original minimum wage. Because the minimum wage is nominal value as dollar not a percentage rate value. We are interested in increase minimum wage rate impact. By taking the log in real minimum wage, we can convert nominal value to percent rate. $\boldsymbol{Z_{it}}$ vectors are explanatory variables measured in state i, year t.

ψ_i is linear time trend by state. α_i is fixed effects specific to each group. τ_t is aggregate time effect common to all states. ϵ_{it} is error term. First, we can set y_{it} which are response variables. It can be various employment rates and fraction of part time, full time.

1. **Target: Employed fraction**

We can set $\boldsymbol{Z_{it}}$ which are sufficiently effect on y_{it} and these are independent (not correlate) real minimum wage. $\boldsymbol{Z_{it}}$ serves to further highlight the independent influence of real minimum wage on y_{it}. Then we can get less biased estimator β. Therefore, we should set appropriate $\boldsymbol{Z_{it}}$ through significant test. We can test all the variables, but we can filter out things that are not possible before that. We can derive an appropriate. $\boldsymbol{Z_{it}}$ based on the total employed variable. The reason why the criteria are set to total employed is that they are represented as a population of all employed fractions. First, $\boldsymbol{Z_{it}}$ should not be a subset of the employed. Therefore, we just need to test a total of three things: Fraction of teens aged 1-19 that are enrolled in school, Fraction of teens aged 16~19 employed part time and employed full time. If the signature test is performed for all combinations after substituting the model's $\boldsymbol{Z_{it}}$. The result is that the p-value does not exceed 0.05 and is significant only for the Fraction of 16-19 employed part time. Now, we fixed $\boldsymbol{Z_{it}}$. We put in total 9 variables : Fraction of teens aged 16-19 that are employed **(employed),** fraction of teens aged 16-19 that are employed in the retail sector **(emp_retail),** fraction of teens 16-19 that are employed in the restaurant sector **(emp_rest)** employed age in 16~17 rate **(employed_1617),** employed age in 18~19 rate **(employed_1819),** employed male rate **(employed m),** employed female rate **(employed f),** employed white rate **(employed w),** employed minorities rate **(employed min)**.

For result, we can find all fraction of teens aged 16~19 employed part time is significant.

Currently, the p-value is 0.000, which is less than 0.05. It means that this $\boldsymbol{Z_{it}}$ is very appropriate. Final model as:

$$y_{it} = \beta log(RMW_{it}) + \gamma * workpt + \psi_i t + \alpha_i + \tau_t + \epsilon_{it}$$

On the other hand, there are 5 significant variables: Fraction of teens aged 16-19 that are employed **(employed),** employed age in 16~17 rate **(employed_1617),** employed female rate **(employed f),** employed white rate **(employed w),** employed minorities rate **(employed min).** I set the significant levels are ***: 0.05, **: 0.1, *:0.2. The total employed and employed minorities rate are very significant variables. Their beta coefficients are -0.053 and -0.1034. The employed age in 16~17 rate and employed female rate are normally significant. Their beta coefficients are -0.061 and -0.0573. Finally, employed white rate white is less significant variable. The beta coefficient is -0.0313.

2. Target: Working time (part time, full time) fraction

In a similar way, it is now time to substitute working time for response variable. Working time is divided into two parts: part time and full time. The data analyzed in other papers are continuous variable, where working time is mostly in hours. But we are designated as rate. Therefore, there is no need to put a separate log. Since the variable type is rate, it can be interpreted that if the part time rate increases, working time increases. Conversely, if the part time rate decreases, it can be interpreted that the working time decreases. Full time is the same as part time. As shown in 1, the model uses the same. We have to determine the appropriate $\boldsymbol{Z_{it}}$ as shown in 1. The leading candidate's variable associated with total 2: Fraction of teens aged 16~19 working time are total employed rate and Fraction of teens aged 1-19 that are enrolled

in school. If we do the significant test, we are lucky to see that our in school predictions are correct. But work part time is not significant at total employed both. Work full time and part time variable is significant the real minimum wage change for working time (part, full). Currently, the p-value is 0.037, which is less than 0.05. It means that our $\boldsymbol{Z_{it}}$ = **inschool** is appropriate.

Final model as:

$$workpt = \beta log(RMW_{it}) + \gamma\_1 * inschool + \psi_i t + \alpha_i + \tau_t + \epsilon_{it}$$

$$workft = \beta log(RMW_{it}) + \gamma\_2 * inschool + \psi_i t + \alpha_i + \tau_t + \epsilon_{it}$$

V. Results

In part 1, there are 5 significant employed variables are Fraction of teens aged 16-19 that are employed **(employed),** employed age in 16~17 rate **(employed_1617),** employed female rate **(employed f),** employed white rate **(employed w),** employed minorities rate **(employed min).** These coefficients are all negative. Therefore, we can conclude that higher real minimum wage , lower employ rate. Especially, employed minorities rate is most critical.

In part 2, real minimum rate significantly affect into working type (it reflect the working time). Both betas are negative. Therefore, we can conclude that higher real minimum wage, lower working time.

<fig.

1: Nominal minimum wage converts into real minimum wage.>

Variables	Mean	SD	25th percentile	75th percentile	Observation
Fraction of teens aged 16-19 that are employed **(employed)**	0.36	0.10	0.30	0.43	1224
Fraction of teens aged 16-19 that are employed in the retail sector **(emp_retail)**	0.19	0.06	0.16	0.23	1224
Fraction of teens 16-19 that are employed in the restaurant sector **(emp_rest)**	0.05	0.02	0.03	0.06	1224
Fraction of teens aged 16-19 that are enrolled in school **(inschool)**	0.15	0.05	0.11	0.18	1224
Fraction of teens aged 16-19 that are employed full time (≥ 30 hours/week) **(workpt)**	0.10	0.03	0.07	0.12	1224
Fraction of teens aged 16-19 that are employed part time (< 30 hours/week) **(workft)**	0.02	0.01	0.01	0.03	1224
Employed age in 16~17 rate **(employed_1617)**	0.27	0.11	0.19	0.34	1224
Employed age in 18~19 rate **(employed_1819)**	0.47	0.11	0.40	0.47	1224
Employed male rate **(employed m)**	0.35	0.11	0.28	0.43	1224
Employed female rate **(employed f)**	0.38	0.11	0.30	0.45	1224
Employed white rate **(employed w)**	0.40	0.11	0.33	0.47	1224
Employed minorities rate **(employed min)**	0.27	0.12	0.20	0.34	1224
Real minimum wage **(RMW)**	3.07	0.31	2.82	3.25	1224

<Summary statistics>

Variables	Real minimum wage	Fraction of employed part time	Beta
Fraction of teens aged 1 6-19 that are employed **(employed)**	0.022*** (0.021)	0.00 (0.022)	-0.053
Fraction of teens aged 1 6-19 that are employed in the retail sector **(emp_retail)**	0.344 (0.015)	0.512 (0.021)	
Fraction of teens 16 -19 t hat are employed in the restaurant sector **(emp_rest)**	0.206 (0.011)	0.00 (0.018)	
Employed age in 16~17 rate **(employed_1617)**	0.054** (0.032)	0.00 (0.043)	-0.061
Employed age in 1 8~19 rate **(employed_1819)**	0.285 (0.035)	0.00 (0.053)	
Employed male rate **(employed m)**	0.214 (0.030)	0.00 (0.035)	
Employed female rate **(employed f)**	0.086** (0.033)	0.00 (0.037)	-0.0573
Employed white rate **(employed w)**	0.199* (0.024)	0.00 (0.029)	-0.0313
Employed minorities rate **(employed min)**	0.042*** (0.051)	0.00 (0.087)	-0.1034

The impact of real minimum wage on various (total 9) employed rate.

Note: blank is unsignificant values. P-value (standard deviation).

Variables	Real minimum wage	Beta
Fraction of teens aged 16-19 that are employed part time (< 30 hours/week) **(workpt)**	0.000*** (0.018)	-0.1785
Fraction of teens aged 16-19 that are employed full time (≥ 30 hours/week) **(workft)**	0.000*** (0.023)	-0.4584

The impact of real minimum wage on wage time(full, part).

Note: P-value (standard deviation).

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All writing in literature review.