The Impact of The Minimum Wage On Other Wages

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Abstract

In this paper, I explore how an increase in the minimum wage impacts wages across occupations according to education levels. I hypothesize that the minimum wage will disproportionally raise wages in the bottom part of the wage distribution and have little bearing on wages in the top half. Wage adjustments are explained by how much they are influenced by the minimum wage and skill level using a fixed effects model on panel data for occupation across 45 states over 15 years that exploits state and year variation. The data shows that there is little evidence that the minimum wage has a diminishing effect across the wage distribution. The results show that wages undergo a linear shift in response to a 1% increase in the minimum wage by either increasing by .6% or decreasing 4-11%, where the upper bound of the decreasing scenario should be accepted with caution.

Intro

The purpose of this paper is to explore the effect of the minimum wage on wages across occupations along the wage distribution. I use occupational education requirements as a proxy for skills to differentiate occupations across the wage distribution. While the economic literature discussing minimum wage pertains mostly to its effects on unemployment, the effect on the wages across occupations along the wage distribution has remained mostly unexplored save for a few papers. This is surprising given that if an increasing minimum wage affected other wages in the economy this could have secondary unemployment (and to some extent inflationary) effects. Further, given the recent income inequality debate, there is an increasing need for original research to arrive at productive, fact-based minimum wage policies.

Past minimum wage research on this topic relied heavily on time series approaches using small data sets and focused primarily on the bottom part of the wage distribution. Consequently, the existing research provides insufficient information to evaluate the policy implications of an increase in the minimum wage on the wage distribution. In contrast, this paper makes use of a rich panel data set and uses panel data models that exploit state and time variations. This paper follows existing literature on how the minimum wage should affect other wages through several mechanisms; through firms' substitution of skilled and unskilled labour, and skilled labours wage comparisons and preference to be compensated more for their effort than unskilled labour.

The underlying hypothesis in this paper is that the minimum wage will create a chain reaction in wages but will taper off and thus only effect wages near the bottom of the distribution. The instinctive approach to this problem is to track how wages change over time in relation to the minimum wage, however this method depends on lagged dependent variables that allow for the possibility of endogeneity to occur; this issue is avoided by using skill levels to differentiate occupational wages along the wage distribution. Skill level is used because wages vary with skill levels; low skilled labour tends to make near the minimum wage while high skilled labour tends to make more than the minimum wage. However, since skill level is not easily quantified, this paper uses education levels as a proxy for skill to differentiate wages along the wage distribution to find how much of wages are explained by the minimum wage for a given education level. This in turn answers how different skill levels (i.e. education levels) are affected and thus how the minimum wage affects the wage distribution. The main results of this paper were statistically insignificant in showing how the minimum wage affects workers with different skill levels and thus could not show that the minimum wage has a diminishing effect across the wage distribution. The results of this paper suggest that the wage distribution undergoes a linear shift by increasing slightly or decreasing substantially depending on the model used.

Literature review and Economic theory

The most extensive research on this topic comes from Grossman (1983), Neumark et al (2002) and to some extent Gramlich (1976). All three primarily analyze the effects of the minimum wage at the bottom of the wage distribution. All three provide various mechanisms of how the minimum wage affects the wage distribution, with the most succinct theory coming from Grossman. She argues that the minimum wage affects the wage distribution through two mechanisms. Her model posits firms whose only inputs are skilled and unskilled labour, in which unskilled labour is paid the minimum wage and skilled labour is paid some higher wage. The first mechanism is a substitution effect between labour groups, in which firms substitute from unskilled workers to skilled workers as an increasing minimum wage makes unskilled labour relatively expensive, pushing the demand for skilled labour and driving up their wages. The second mechanism is that skilled labour's effort/productivity is a function of wage comparisons in which skilled labour's productivity level is contingent on its wages being higher than unskilled labour. Given unskilled labour's lower productivity level, skilled labourers believe they deserve to be paid more for their higher productivity. Grossman models how responsive skilled labour is to changes in unskilled labours wages as the elasticity of effort. As elasticity of effort decreases, skilled labour is less reactive to changes in the unskilled labour because the gap between their wages might be large or because differences in efforts/productivity are marginal. An increase in the minimum wage that brings unskilled wages closer to skilled wages will cause skilled labour to reduce their productivity since they now find it unjust to be paid a similar wage for more work, and so they now find it optimal to reduce their effort/productivity levels. This in turn forces firms to raise skilled labours wages to maintain previous levels of productivity. However, in an economy where there exists a spectrum of skills and wages, the above logic creates a chain reaction: group A compares its wages unfavourably to the minimum wage. The firm responds by raising group A's wages. Now group B compares its wages with group A and finds it optimal to reduce its efforts, causing its employer to increase its wages, which in turn deteriorates group C's relative wages, and so on and so forth. Although this dominoes effect could potentially go unimpeded, thus shifting everyone's wages by the increase in the minimum wage, it should not. As Grossman argues, this dominoes effect ends when one group has a zero elasticity of effort and does not respond by decreasing their effort.

The existing literature uses a mix of time series and panel data to estimate the effects of the minimum wage on the wage distribution. In Grossman's paper she uses a moving average model, which is a type of panel data model with lagged independent variables. She uses data on US occupational wages in 16 cities in the North-East states from 1960-1975. The model has wages in a given occupation in a given city in a given year as a function of all lagged minimum wages in the same and prior years as well as the unemployment and the consumer price index. She only uses wages of a select few occupations that are near the minimum wage to estimate the effect of the minimum wage on wages near the bottom. She finds that wages of "white collar" jobs near the bottom of the wage distribution (she uses "stenographers" and "clerks") do not move much after a minimum wage hike; however, "blue collar" workers near the minimum wage do undergo a wage change (she examines male custodians). In a similar fashion, Gramlich regresses wages today on lagged wages and minimum wages in a moving average form. Using similar panel data to Grossman, Gramlich finds that the 1974 federal minimum wage hike by

25% from $1.60 to $2.00 raised all wages by .8% (shift in the mean), and wages near the bottom of the distribution by 3.5%. Finally, Neumark et al makes use of US panel data from 1979-97. These authors use a contemporaneous effect model which is a form of fixed effects model with certain lagged variables, which tracks percentage changes of wages from one year to the next and relates it to a moving average percentage change of minimum wages from one year to the next. They used lagged variables as they point out that wages are forward looking, and the effects of the minimum wage happened a few periods prior to the actual implementation of the policy.

Neumark et al's strategy is see how the minimum wage effects wages at different levels of the distribution by regressing wages on the minimum wage grouped by percentiles. Neumark et al find that wages are most responsive near the bottom and even wages in the top percentiles have small yet statistically significant elasticities to the minimum wage hike.

Data Description

The data on the minimum wage comes from the Federal Reserve of Economic Data (FRED) which contains data from 45 US states from 2002 to 2017. In this paper, I make use of panel data on occupational wages from the Bureau of Labour Statistics (BLS) which contains the average hourly wages for each occupation in every US state in each year from 2002 to 2017. Education levels for each occupation comes from the BLS as well. The data used in this paper was limited by the minimum wage data. Although the wage data comes from all 50 US states, I could only use 45 states since 5 states did not have complete minimum wage data from the FRED. Although some states have minimum wages below the federal minimum wage, I set every state minimum wage as the max of the federal minimum wage and state minimum wage. The reason for this is that minimum wages below the federal level are mostly nominal and apply only to a small share of workers exempt from the federal minimum wages, such as farmers, tipped workers, and salaried professionals. The education data matches every occupation with a typical education level required for entry into that occupation, which I use as a proxy for skill level for each occupation. This education data set is only available for 2016, as such I apply it to the occupational data set for every year. Obviously, this is not optimal, but it is the only data set available. In the occupational wages data, every state and year has different amounts of occupations, with a total occupational observation of 261,063. This is because states vary in the size and type of their economy which results with states having unique jobs not found in other states and varying in the quantity of jobs. For example, California will have more occupations than Nebraska simply due to its difference in economic size and will naturally have more jobs not found in Nebraska. California might have 800 unique occupations, whereas Nebraska will only have 300. As such, the panel data will be unbalanced.

Figure 1. Max and Min minimum wages over time

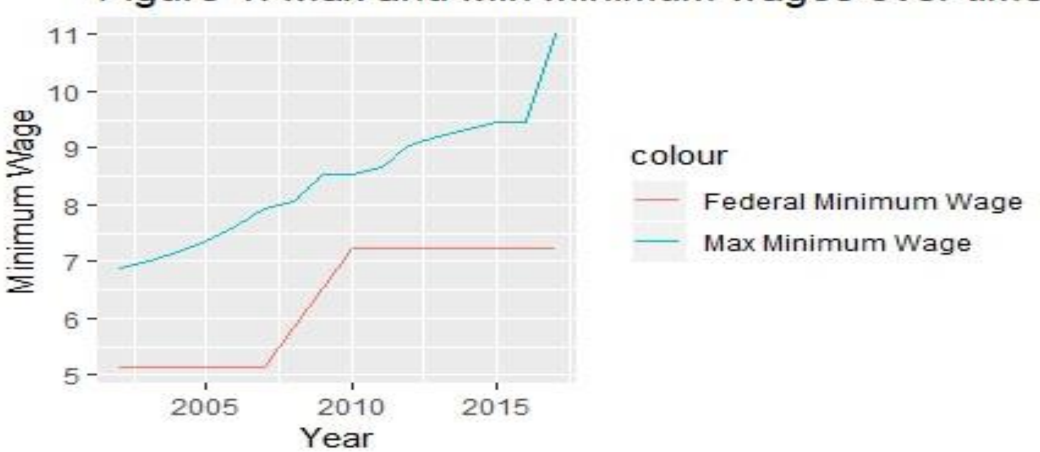

Figure 1 shows the upper and lower bounds of the minimum wage across time.

Figure 2. Minimum Wage densities

Figure 2 shows the density plots of the minimum wages across all states in 2002 and 2017. The federal minimum wage was \$5.15 and \$7.25 in 2002 and 2017 respectively.

Empirical Analysis

As noted in the literature review section, most of the existing literature on this topic has used either panel data models with a time series approach focused exclusively at the bottom of the wage distribution or has used fixed effects models on panel data in a quantile regression.

The most common model is to use dynamic panel data of the form:

$$w_{ost} = \beta_0 + \sum_{i=1} \beta_i w_{o,s,t-i} \sum_{i=0} \gamma m w_{o,s,t-i} + \epsilon_{ist} \tag{1}$$

The presence of the lagged dependent variables allows for the possibility of endogeneity to occur. By regressing lagged wages on current wages, the two could be serially correlated which would result with standard errors that might impact the reliability of the coefficients. By not including lagged wages, my estimates avoid this issue by using education, which is not serially correlated with wages.

Using panel data on state minimum wages and occupation wages permits a panel data analysis of the minimum wage effects, exploiting the variation in the minimum wage at the state and year level. My efforts to explain the minimum wage effects on the wage distribution uses a fixed effects model on panel data and uses education as a proxy for the skill requirements for a given occupation. Specifically, the panel data set permits me to estimate a fixed effects model of the form:

$$\ln(w_{oit}) = \beta_0 + \beta_1 \ln(mw_{it}) + \beta_2 educ_o + \beta_3 \ln(mw_{it})\ educ_o + \gamma_i + \delta_t + \epsilon_{oit} \qquad (2)$$

Where o indexes occupations, i indexes states and t indexes years. State is a set of fixed state effects, and year is a set of fixed year effects. The model exploits the variation in minimum wages at the state and year level. mw_{it} is the higher of the state and federal log minimum wage, w_{oit} denotes the occupations log average hourly wage, and $educ_{oit}$ is the minimum amount of schooling years required for each occupation which acts as a proxy for the skill level. For the analysis, an unbalanced panel data of 261,063 observations are used. I take the natural logs of hourly wages and the minimum wages. I do so because the wage distribution has a highly rightskewed chi-square distribution and is truncated at the minimum wage. By log transforming the wages it normalizes the distribution, preventing estimates of negative wages and allowing for the estimates to be more easily interpreted as percentage changes (elasticities) rather than as absolute changes in wage. Throughout this analysis, I assume epsilon is orthogonal to the regressors, but that state and year effects may be correlated with the other regressors.

The main parameter of interest is β_3 which captures the interaction effect between occupations skill (proxied by education) and the minimum wage. That is, the effect the minimum wage has on wages of occupations with different skill requirements. This could be understood as the occupation hourly wages by skill sensitivity to the minimum wage; that is, how the minimum wage affects wages as we move up in the distribution and therefore also in the "skill rankings". I expect this coefficient to be negative because high skilled labour will feel less of an impact on wages from the minimum wage than low skilled workers would as skilled labour wages tend to be further away from the minimum wage in the distribution. Following the Grossman efforts effect model, this coefficient estimate represents the diminishing "dominoes effect" of the minimum wage in which it is suggested that eventually the minimum wage will stop having an effect when an occupation (which will also have a high skill level) with zero elasticity of effort is reached. This coefficient is of central interest because it allows us to see how the minimum wage effects wages differently across the distribution. As the theory suggests, as one moves further from the bottom of the distribution, labour skill/education rises, and so the minimum wage should reveal less about wages the further away one is from the bottom. We use this term to model the strength of the dominoes effect on wages as one moves further to the right. I expect it to be negative because it will "mitigate" the effect an increasing minimum wage has on wages as education rises. In other words, we want to "penalize" the effect the minimum wage has on wages by reducing it by this coefficient. The other coefficients are almost intuitive: β_1 captures the effect of minimum wages on the occupations' wages which will intrinsically be positive since a minimum wage hike will raise wages at the bottom and can only raise other wages – the theory does not present a direct mechanism by which the wage hike can directly and permanently reduce wages. Finally, β_2 captures the effect of skill on wages which should be positive since higher skills/education is associated with higher wages, a stylized fact that is mostly true in the US context.

The above regression is the “full” model that I use to analyze the minimum wage effects. However, I also analyze three nested models to explicitly show how the estimates change with more explanatory variables. I will include the following additional models:

$$\ln(w_{oit}) = \beta_0 + \beta_1 \ln(mw_{it}) + \delta year_t + \epsilon_{oit} \quad (3)$$

$$\ln(w_{oit}) = \beta_0 + \beta_1 \ln(mw_{it}) + \gamma state_i + \delta year_t + \epsilon_{oit} \quad (4)$$

$$\ln(w_{oit}) = \beta_0 + \beta_1 \ln(mw_{it}) + \beta_2 educ_{oit} + \beta_3 \ln(mw_{it})\ educ_{oit} + \delta year_t + \epsilon_{oit} \quad (5)$$

In the estimation of the regression estimates for all the models, the standard errors are clustered by state. This allows for heteroskedasticity and for errors to be correlated within states across occupations and over time, while treating the errors as uncorrelated across states. This allows for unbiased standard error estimates. Since the minimum wage varies between states, if we did not cluster we would get correlated errors resulting with conventional standard errors that are incorrect and could ultimately lead to biased confidence in the precision of the models estimates.

The standard within-group estimator is used to estimate the fixed-effects models.

Results

Table (1) reports the estimates and their standard errors of the panel data fixed effects model for the effects on occupational log hourly wages. Column 2 is equation (3), column 3 is equation (4), column 4 is equation (5) and column 5 is equation (2) from above.

Table 1 Dependent variable: Log Hourly Wages				
Regressor	(2)	(3)	(4)	(5)
Log Minimum Wage: β_1	.6354*** (.012)	-11.3856*** (.618)	.6388*** (.0128)	-4.535*** (.2804)
Education: β_2			.1225*** (.0046)	.1054*** (.0045)
Education: Log Minimum Wage: β_3			-.0016 (.0024)	.0002 (.002)
State Effects?	No	Yes	No	Yes
Year Effects?	Yes	Yes	Yes	Yes
Occupations	261,063	261,063	261,063	261,063
States	45	45	45	45
Years	2002-2017	2002-2017	2002-2017	2002-2017
Clustered Standard Errors?	Yes	Yes	Yes	Yes
Adjusted R^2	.0530	.0191	.5692	.3698

These regressions were estimated using panel data for 45 U.S. states. Regressions (1) through (4) use data for all years 2002 to 2017. Standard clustered errors are given in parentheses under the coefficients. The individual coefficients are statistically significant at the *10%, **5%, or ***1% significance level.

The fixed effects estimates are interpreted as follows: β_1 is the measure of the elasticities in the hourly wage or annual income resulting from a 1% increase in the minimum wage; β_2 is the measure of the elasticity of the dependent variables resulting from a one year increase in years of schooling; and β_3 represents the change in elasticity(i.e. for a given occupation with a given education level, say α, the elasticity would be $\beta_1 + \alpha\beta_3$). Column (2) presents results for the year fixed effects regression which is a statistically significant positive elasticity of .63, suggesting that a 1% increase in the minimum wage results in a .63% increase in hourly wages. Column (3) presents the results for the state and year fixed effects regression which is a statistically significant positive elasticity of -11.385, suggesting that a 1% increase in the minimum wage results with a 11.39% decrease in hourly wages. However, by including state fixed effects one might suggest that the positive coefficient of regression (3) is the result of omitted variable bias: the regressions R^2 drops from .0531 to .0191 when state fixed effects are included. Evidently, the state fixed effects do not account for much of the variation in the data. A lot changes when we include education and the education and minimum wage interaction terms. Column (4) presents the results for the year fixed effects regression with statistically significant positive coefficients of .638 and .1225 for the minimum wage and education level, respectively. This suggests that a 1% increase in the minimum wage results with a .64% increase in hourly wages and a 1-year increase in education results in a 12.25% increase in hourly wages. The final coefficient is a non-statistically significant negative coefficient of -.16%; the lack of significance and small magnitude can be interpreted as wages responding to a 1% minimum wage hike by decreasing by a small amount for a given education level. For example, for 10 more years of education, wages decrease by 1.6% with a wage hike, which besides being statistically insignificant is also very small. By including education and the interaction term, the regression R^2 jumps from .053 to .569 as compared to regression (3) which suggests that education accounts for a large amount of the variation in the data. Finally, column (5) is a similar regression as that in column (4) but is extended to be the state and year fixed effects. The results in column (5) follows the same logic as the previous regression: the hourly wage drops by 4.35% when the minimum wage increases by 1% and the estimate is statistically significant; increase by 11.1% when education rises by a year and is statistically significant; each additional year of educational requirement increases the wage response to a change in the minimum wage by .02%, the estimate is small and not statistically significant. This again shows that, for example, for 10 years more of education wages increase by .2% with a wage hike, a small and statistically insignificant amount. What is interesting is that by including state fixed effects, R^2 drops from .5692 to .3698 as compared to the regression in column (4), which suggests that most of the variation in the data is due to state-specific time invariant characteristics that correlate with both the minimum wage level and hourly wage level.

The regression in columns (3), (4) and (5) have a few interesting results. In column (3) there are two interesting observations. First, the minimum wage coefficient β_1 is a large negative value, suggesting that when the minimum wage increases then all occupational wages decrease. This result is unexpected as it runs counter to the economic theory in the literature. Second, β_1 is quite large when compared to the other $\beta_1's$ in the other regressions, suggesting that there is some collinearity with the state fixed effects so that β_1 in column (3) is one of the states fixed effects and this result should be taken with caution. In column (5), the minimum wage coefficient β_1 is a large negative value of -4.53%. This again is unexpected as it suggests that occupational wages fall in response to a minimum wage increase. Further, since both columns (3) and (5) include state fixed effects, this suggest that occupational wages fall as a worker moves from a state with a low minimum wage to a state with a high minimum wage.

For both regressions in columns (4) and (5), the education and minimum wage interaction term, β_3, are both not significantly different from zero at the 10% significance level and are both small in magnitude. This is important since it explains the diminishing dominoes effect of the minimum wage on hourly wages. Since we use skill as the determinant of position in the wage distribution, as the minimum wage rises, all occupations are affected independently from their educational requirements. Essentially, the minimum wage causes a linear shift in the wage distribution. That is, occupations' wages are affected by the same amount when the minimum wage increases. The lack of significance in β_3 means that the effect of an increasing minimum wage is not "mitigated" for different skill levels. To illustrate, an occupation with high skill requirements at the top of the wage distribution will have its wages affected by a minimum wage hike by the same amount as an occupation with little skill requirements at the bottom of the distribution. More specifically, the regressions in columns (3) and (5) suggest that an increase in the minimum wage by 1% will substantially reduce all occupational wages by 11.38% and 4.53% respectively and increase under regressions in columns (2) and (4) by .635% and .638%, respectively. At face value, these responses to an increasing minimum wage is at best a small shift up in the occupational wage distribution by around .6% and at worst a shift down by around 4-11%, depending on the specific model employed.

By including state fixed effects, the minimum wage coefficient β_1 is reduced dramatically from .638 in column (4) to -4.53 in column (5). When including state constant variables, the evidence suggests that states with high minimum wages have lower hourly wages as compared to their federal minimum wage counterparts. When including state fixed effects, the education and minimum wage interaction term β_3 is increased somewhat from -.0015 in column (4) to .0002 in column (5). This suggests that by including variables constant to all states, a worker with a given education level will have higher hourly wages as he moves from a low minimum wage state to one with a higher minimum wage. By including education and the education and minimum wage interaction term in columns (4), the R^2 jumps from .01 in column (3) to .569 in column (4). This suggests that most of the variation in hourly wages is a result of education, not the minimum wage.

My results are different from the established literature for two reasons. First, my results suggest that an increase in the minimum wage can shift the wage distribution down. Second, my results do not suggest that the minimum wage has a diminishing dominoes effect on the wage distribution and so the whole distribution is affected by an increase in the minimum wage, independent of the occupations' educational requirements. Further, my methods vary from the established literature since I used fixed effects to exploit time and state variation in the minimum wage, and I used education instead of wages as a regressor to model the effects on the wage distribution to avoid endogeneity issues.

Conclusion

In this paper, I present evidence on wage adjustments that occur in response to minimum wage increases. The main contribution of this paper is that it estimates these adjustments while at the same time avoiding issues of endogeneity that are common in the literature. The evidence suggests that the wage distribution undergoes a linear shift, up or down depending on the model employed, independent of occupational skill requirements. There is little evidence to suggest that the minimum wage has a diminishing effect as one moves up the wage distribution. The results in this paper suggest that the wage distribution, for all occupations independent of their educational requirements, reacts to a 1% increase in the minimum wage by either increasing by around .6%, or decreasing by around 4-11%, depending on the model employed.

From a policy perspective these results are important for two main reasons. First, the minimum wage does not usually increase by 1%, but more often by some larger amount. For example, in 2017 the state of New York increased its minimum wage by 15.4% from 13$ to 15$. If the minimum wage causes the distribution to undergo a linear shift right, this is extremely relevant from an unemployment and inflation perspective. Second, in the case where the wage distribution falls then this is obviously a reduction in welfare for all workers.

Further research should be done to verify whether there is a diminishing effect across the wage distribution.

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