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Article

Long-run effects of minimum wage on labor market dynamics

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SUMMARY

The topic of minimum wage in the United States (U.S.) has been and continues to be hotly debated by politicians and economists, with no agreement on the appropriate level. Critics of higher minimum wage cite the standard economic theory of supply and demand, while proponents point to monopsonies: market structures where a single buyer dominates, in this case, the labor market. Raising the minimum wage may initiate market exit for some firms, shift some industries to become more capital-intensive, and result in low-skilled worker layoffs and reduced worker benefits. This study tested the hypothesis that increasing the minimum wage would have negative effects on the annual average employment, taxable wages, and number of firms in the market. Using local projection framework, we analyzed the long-run effects of minimum wage policy, namely effects that can occur after multiple years, using panel data from all U.S. states and territories from 2010 to 2019. We used local projections with two-way fixed effects to estimate the dynamic effect of minimum wage on annual average employment, taxable annual wages, and average annual firm count. We found that, in the long run, raising the minimum wage correlated negatively with employment and taxable wages but had no impact on firm count.

INTRODUCTION

The minimum wage is the lowest hourly rate at which an employee can be legally compensated. Since the inception of the federal minimum wage in 1938, economists and politicians have disagreed over the proper level at which it should be set. With the most recent increase to the national minimum wage to $7.25 in 2009, public support for a $15 federal minimum wage has only grown since the Covid-19 pandemic (1).

In economic theory, two major concepts are relevant when discussing the impact of minimum wage increases on the labor market: a competitive market and a monopsony. A competitive market consists of many buyers and sellers, with an equilibrium price set where quantity supplied meets quantity demanded. When workers and employers are legally bound to agree to a pay rate above the equilibrium price, known as a binding price floor, the result is a decrease in quantity demanded and an increase in quantity supplied, leading to a surplus of labor (**Figure 1**). This labor surplus is reflected in higher unemployment and/or lower financial compensation overall. Given that minimum wages are generally binding for low-marginal-product labor markets, where adding one additional unit of input leads to only a small increase in output, those who are most directly affected are low-skilled workers (2). In addition, the loss of potential transactions owing to the binding price floor creates an inefficient allocation of resources, known as deadweight loss (2).

In the real world, firms are able to produce with a variety of inputs. The combination of high-skilled labor, low-skilled labor, and capital, determines some effects of the minimum wage. Additionally, how substitutable these factors are for each other over time also plays a role. Firms may choose to employ alternative resources unconstrained by price floors to maximize profits. A real-life example of this would be in New York City, where the implementation of a minimum wage of $15 led to many car washes choosing to lay off workers and employ car-washing machines instead (3). In some cases, car washes simply could not afford higher labor costs and went out of business, putting even more workers out of their jobs (3).

An additional component of the debate around minimum wage is the disparate impact of minimum wage on capital- and labor-intensive firms. A labor-intensive firm that employs mostly human laborers and compensates below the proposed higher minimum wage will have to adapt its payroll more than a firm that operates with an emphasis on capital (4). Capital-intensive firms, such as in auto manufacturing, also typically employ highly skilled workers. One scenario in which firms might shift back to being labor-intensive and re-hire low-skilled laborers is if inflation raises prices across the board, aligning the minimum wage with the market equilibrium. In the long run, the greatest source of inflation is the government's expansion of money supply, which leads to price increases across the board. The real price of low-skilled labor may not have changed, but the nominal wage may have been pushed closer to the set minimum wage, which is not indexed to inflation (5). The net result is that unless inflation or some phenomenon alters market factors, capital-intensive firms are favored over labor-intensive firms.

On the contrary, monopsony provides an alternative view of the labor market. In contrast to the conventional competitive view, some labor markets may have only one employer. In the monopsony model, labor is assumed to be homogeneous, suppliers of labor are numerous, and the monopsony has considerable power in setting market prices (6). An example of a real-life monopsony is a mining company that serves as the sole employer in a small town. Monopsonies pay workers less and hire fewer workers than they would in a competitive market (**Figure 2**). This is because as a monopsony, the firm

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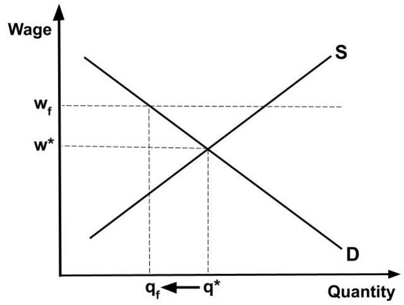

Figure 1: Competitive Market Graph. The graph illustrates a binding price floor in a competitive market. The variables w* and q* are the respective wage and quantity in a competitive market. The variables w_f and q_f are the respective wage and quantity in the presence of a binding price floor. D is demand and S is supply. The price floor is binding, as it is set above the wage that the market has determined, leading to a higher quantity supplied, and a lower quantity demanded, thus creating a surplus of labor.

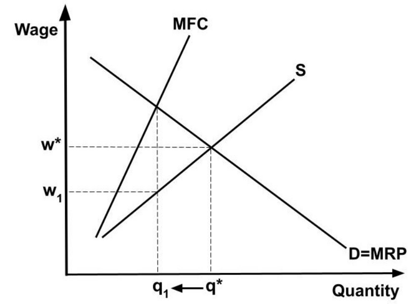

Figure 2: Monopsony Market Graph. The graph illustrates equilibrium price and quantity in a monopsonistic market structure. The variables w* and q*, are the respective wage and quantity in a competitive market. The variables w_f and q_f, are the respective wage and quantity in a monopsony. D is demand, which equals marginal revenue product (MRP), S is supply, and MFC is marginal factor cost. In a monopsony market, there is a lower quantity of labor and a lower wage than compared to a competitive market, as the monopsony must increase the wage rate for all its employees each time it wants to hire an additional worker.

now factors in the entire up-sloping market supply curve. If the firm were to hire another worker, it would have to raise the wages offered, which would require the firm to also pay all its workers that new higher wage in order to retain its workforce. Since the supply curve represents the wages at which workers are willing and able to supply their labor, the fact that it is lower than the marginal cost of labor means that at the profit-maximizing quantity, the firm can pay workers a lower wage compared to the true cost of hiring them (6). For these reasons, under a monopsony model, a minimum wage increase boosts worker pay without driving the firm out of business. Additionally, a modest minimum wage increase would not increase unemployment, because the firm would still earn economic profit.

It is worth noting that firms in the real world operate somewhere on a spectrum between perfectly competitive and monopsony. While some labor markets may look like monopsonies, they may experience competition over time due to entry or implicit competition. Thus, it is important to analyze the effects of minimum wage over time and not to fixate on one discrete point in time, as these points represent snapshots of a dynamic market process.

Our study aims to fill a gap in the literature on the long-run effects of the minimum wage, as many studies do not distinguish between short- and long-run effects. The period of our analysis, 2010-2019, was relatively peaceful overall and did not include any major economic downturn, allowing for better long-run analysis.

Due to the limited availability of aggregate state data regarding the private sector, we were constrained by the categorization of the data by our dataset. Consequently, we chose to comprehensively analyze three variables: annual average employment, taxable annual wages, and average annual firm count. We hypothesized that increasing the minimum wage would have negative effects on the annual average employment, taxable wages, and number of firms in the market. We ran a simple regression, regressing annual average employment, annual taxable wages, and annual firm count against the minimum wage. Given the value of long-run analysis, we charted the variables over the course of six years. For the first variable, our results indicated a long-run negative correlation between annual average employment and minimum wage hikes, which means low-wage labor markets lean more towards a competitive structure. For the second variable, our results showed a negative long-run correlation between annual taxable wages and minimum wage hikes. For the third variable, average firm count, our results found no long-run correlation between firm count and minimum wage hikes, meaning that firms offset higher labor costs through substituting inputs.

RESULTS

To examine the effects of minimum wage increases on annual average employment level, taxable annual wages, and annual average firm count, we regressed those variables against minimum wage and utilized panel local projection. The decision to utilize the local projection framework was made to understand the potentially differentiated effects that minimum wage may have on our variables of interest over time. We present and discuss the main empirical results, starting with the regression analyses, followed by graphs of panel local projection results. We used the natural logarithm of the annual average employment level, taxable annual wages, and annual average firm count, as well as the value of the minimum wage. Thus, the coefficients in our regression model can be interpreted as elasticities. For example, a coefficient of 0.1 for the variable tested indicates that a 1% increase in the minimum wage is associated with an approximately 0.1% increase in the variable being regressed.

To analyze the effect of minimum wage on firm employment, we regressed average annual employment against minimum wage while controlling for the annual average firm count. The first regression indicated that for every 1% increase in the minimum wage, the average annual employment decreased by 0.0124%, thus indicating a negative correlation between the two variables (**Table 1**). Note that the standard error is three times larger than the estimate, indicating that this result is not statistically significant.

To analyze the effect of minimum wage on wages, we regressed taxable annual wages against minimum wage. The second regression indicated that a 1% increase in the minimum wage correlates with a 0.0224% decrease in taxable

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annual wages, and once again, we observed that the standard error is greater than the estimated value (**Table 2**).

To analyze the effect of minimum wage on firm count, we regressed annual average firm count against minimum wage. This time, a 1% increase in the minimum wage precedes a decrease of 0.005% in the number of operating firms (**Table 3**). The standard error value of 0.0411 also renders any conclusion uncertain.

The static regression shows a potentially correlative relationship between the minimum wage level and a certain variable, but it does not show a difference in the potentially delayed impact over the years. Looking at a longer time span requires a comparison of the short- and long-run effects to understand the separate impacts of each. To better understand the long-run effects of minimum wage, we used a local projection framework on the same variables we regressed above. This allowed us to observe the long-run effects of the minimum wage in terms of horizons, which are defined as the future points or periods from the time of an intervention are analyzed. In our case, the intervention is the minimum wage, and the horizons in this paper are expressed in years. For ease of interpretation, we graphed out the results for our variables annual average employment, taxable annual wages, and annual average firm count, and labelled them Local Projection A, B, and C.

The results for Local Projection A corresponded with the variables in the first regression, which is annual average employment regressed against minimum wage while controlling for firm count. However, at the second horizon and beyond, with 90% confidence, we know that an increase in minimum wage correlates negatively with annual average employment, factoring in the variance in the number of firms. The strongest correlation can be found with a horizon of five years, where accounting for firm count, a 1% increase in the minimum wage lowers the outcome variable by 0.088% (**Figure 3**).

Variable	Coefficient	Standard Error	t-value	p-value	Adjusted R^2
Minimum wage	-0.0124	0.0342	-0.363	0.718	0.999

Table 1: Relationship between increase in minimum wage and annual average employment. Data was controlled for variance in firm count. A simple regression model was used. For every 1% increase in the minimum wage, the average annual employment is expected to decrease by 0.0124%. Although there is a negative correlation, the result is not significant p = 0.718.

Variable	Coefficient	Standard Error	t-value	p-value	Adjusted R^2
Minimum wage	-0.0224	0.0910	-0.246	0.807	0.995

Table 2: Relationship between increase in minimum wage and annual taxable wages. A simple regression model was used. A 1% increase in the minimum wage precedes a 0.0224% decrease in taxable annual wages. The output indicates negative correlation, but the result is not significant due to the standard error and p = 0.807.

Variable	Coefficient	Standard Error	t-value	p-value	Adjusted R^2
Minimum wage	-0.005	0.0411	-0.122	0.903	0.999

Table 3: Relationship between increase in minimum wage and establishment count. A simple regression model was used. A 1% increase in the minimum wage is correlated with a decrease of 0.005% in the number of operating firms. The coefficient is once again negative, but the standard error and p-value render the result not significant.

The results for Local Projection B corresponded with the variables in the second regression, which is taxable annual wages regressed against minimum wage. Beginning a little past the second horizon of two years, we found with 90% confidence that increasing the minimum wage decreased the taxable annual wages. The strongest correlation was once again at a horizon of five years, where a 1% increase in the minimum wage correlated with taxable annual wages by 0.366% (**Figure 4**). This result was consistent with the previous local projection, as lower employment would generally imply lower wages received by workers as an aggregate.

The results for Local Projection C corresponded with the variables in the third regression, which is annual average firm count regressed against minimum wage, although the interpretation was ambiguous. Across all horizons, the effect of the minimum wage on firm count was negligible, given the wide variance of the confidence interval from positive to negative correlation (**Figure 5**).

DISCUSSION

We analyzed the long-run effects of increases in minimum wage on annual average employment, taxable annual wages, and firm count using data collected at the state level. We used regressions and local projection framework with two-way fixed effects. This allowed us to not have to worry about factors which stay the same within each state but differ across states. In the long run, increasing minimum wage correlates negatively with annual average employment and taxable annual wages, but has no effect on firm count. This suggests firms are having to adjust to changes in their cost of labor but very few firms are going out of business due to higher minimum wages.

Among other variables, this study analyzed changes in employment level because of changes in minimum wage. A 1994 study examined the short-run effects of minimum wages using difference-in-difference estimation (7). Difference-in-difference is a method that compares the changes in outcomes over time between a treatment group, which experiences the minimum wage increase, and a control group, which does not. This helps determine whether the treatment caused the change by assuming that both groups would change similarly without the treatment. The study focused on employment changes in fast-food restaurants, an industry that is likely to

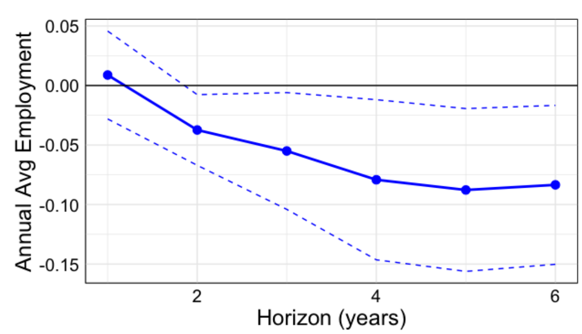

Figure 3: Local Projection A: Average annual employment across horizons up to six years. The dotted blue lines represent a 90% confidence interval, and the y-axis is expressed as a percentage change in annual average employment after a 1% increase in minimum wage.

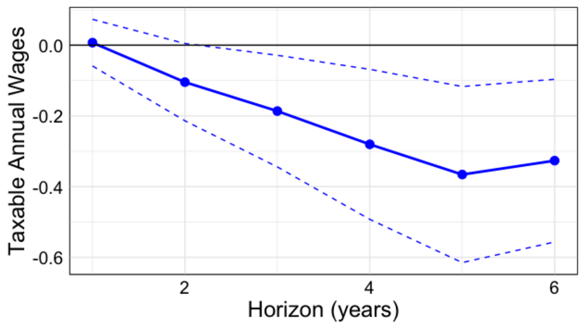

Figure 4: Local Projection B: Taxable annual wages across horizons up to six years. The dotted blue lines represent a 90% confidence interval, and the y-axis is expressed as a percentage change in taxable annual wages after a 1% increase in minimum wage.

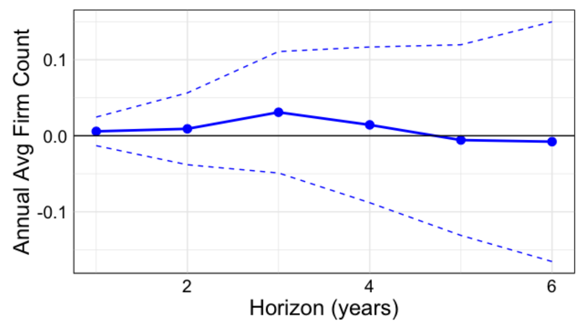

Figure 5: Local Projection C: Annual average firm count across horizons up to six years. The dotted blue lines represent a 90% confidence interval, and the y-axis is expressed as a percentage change in annual average firm count after a 1% increase in minimum wage.

be affected by changes in minimum wage (7). The difference-in-difference study was done in New Jersey, which had a wage hike from $4.25 to $5.05 per hour, and the neighboring state of Pennsylvania, whose minimum wage stayed at $4.25 (7). The authors concluded that the minimum wage increase did not have a significant effect on employment (7). Similarly, a 2008 meta-analysis also focused on employment, and the authors concluded that increases in minimum wage decreased the employment rate, with especially pernicious effects on low-skilled workers (8). However, these studies focused on the immediate to short-run impact, mostly under four years, while we examined employment changes in the long run, defined as five years or more.

A study in 2022 also used a difference-in-difference method to analyze employment changes based on the different minimum wage policies of the cities of Minneapolis and Saint Paul (9). The authors found decreased retail and restaurant employment rates due to wage hikes, even accounting for the Covid-19 pandemic and social disruption (9).

An additional 2022 study analyzed the effect of raising the minimum wage on both low-wage workers and the private sector in Seattle using the synthetic control method (10). The authors found a decrease in the total hours worked, with significant reductions for less-experienced workers (10). Our analysis yielded a similar conclusion.

From a methodological standpoint, our study differs from those previously mentioned. Two studies used difference-in-differences, another compiled and analyzed other studies and one study used a synthetic control (7-10). Instead, we used panel data to run fixed-effect regressions and panel local projections. The benefit of using a fixed-effect model is that it controls for factors within each state that did not change over time. This allowed our analysis to be more robust in the face of unseen variables, such local economic conditions, that are consistent within each state but vary across states. It is important to note that states have their own minimum wages, distinct from the federal standard, which adds variance to the data used in this study.

The data for the first regression, annual average employment, which controls for the firm count, revealed a negative correlation between minimum wage and employment rate in the long run. This suggests that in the short run, firms may have limited options in adjusting their worker payrolls and production inputs, but in the long run they offset some of the higher labor costs by laying off workers. Nonetheless, the overall negative marginal correlation suggests that firms may also employ other methods to offset higher labor costs, although this conclusion cannot be drawn directly from this study. By laying off workers, firms would need to look for alternative resources to maintain production, such as passing on the price to consumers and lowering benefits such as insurance (11).

The correlation between minimum wage and taxable annual wages was also negative in the long run. The correlation was slightly stronger than the results for annual average employment, suggesting that the effects of the minimum wage are not impactful or that other forms of financial compensation, such as taxable benefits, may have been lowered. Additionally, from a tax viewpoint, this negative limited correlation suggests that increasing the minimum wage lowers tax revenue.

Finally, we did not find any effects of minimum wage on firm count in the long run. This result suggests that most firms can absorb higher labor costs, as very few firms left the market, in response to hikes in minimum wage. A fraction of industries has wage rates that are affected by minimum wage hikes, and firms likely employed various methods to offset higher labor costs rather than only laying off lower-skilled workers in the short run. However, in the long run, where all inputs are variable, firms could lay off some lower-skilled workers and use more capital or high-skilled labor. In other words, firms could adapt to changes in the price of low-skilled labor, hence it is unlikely for most firms to be driven out of business by mostly gradual minimum wage hikes.

Overall, this study found a decrease in employment and taxable wages from a review of state minimum wage hikes in the long run from 2010 to 2019, with no effect on firm count. Given the complexity of the minimum wage issue, there is always more nuance to be uncovered, such as the different effects of minimum wage increases on different industries. Future research could also examine the effects of minimum wage increases over a longer period to see if and how the effects vary when financial crises and inflation are considered. Additional variables not considered during this study, such as changes in product prices and non-monetary financial compensation, could also provide an outlet for firms to offset higher labor costs. Ultimately, it is clear that minimum wage affects many aspects of the private sector, and it is crucial to understand its effects on the economy in the long run.

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MATERIALS AND METHODS

We studied the time frame from 2010 to 2019, representing a period of low inflation and relative economic stability, which allows for better analysis of the sole effect of minimum wage increases. This was the longest recent time frame we could study without including the financial crisis of 2008 and the COVID-19 pandemic. We measured three outcome variables against minimum wage increases: annual average employment while controlling for firm count, taxable annual wages, and annual average firm count. We used state minimum wage data for all 50 US states, Puerto Rico, and the Virgin Islands. Additionally, we collected state-level data from the Department of Labor's website (12). To run regressions and use local projections, using the unit year-by-state, we used the panel data for the annual average employment, annual taxable wages, and annual establishment (firm) count, which we sourced from the Bureau of Labor's Quarterly Census of Employment and Earnings (13).

We ran both a static regression, which showed short-run effects, and a panel projection framework, which yielded long-run effects. The equation we used to run the regressions is as follows:

$$Y_{it} = \alpha_i + T_t + \beta M_{it} + X_{it}\zeta_i + \varepsilon_{it} \quad \textbf{(Eqn 1)}$$

In **Eqn 1**, the outcome variable 'Y' for state 'i' at time 't' is determined by the states fixed effect 'α', time fixed effect 'T', the coefficient 'β' on minimum wage 'M' for state 'i' at time 't', in addition to any control variables 'X' & 'ζ' and the residuals for each specific state 'ε'.

Additionally, the equation for the local projection framework is:

$$y_{i,\,t+h} - y_{i,t|} = \alpha_i + T_t + \beta_h M_{i,t} + X_{it}\zeta_i + \varepsilon_{it} \quad \textbf{(Eqn 2)}$$

In **Eqn 2**, 'y', the outcome variable for state 'i' at time 't' plus horizon 'h', is subtracted by the outcome variable 'y' for state 'i' at time 't'. This difference equals the sum of the states fixed effect 'α', time fixed effect 'T', and the coefficient 'β' for horizon 'h' on minimum wage 'M' for state 'i' at time 't', along with any controls 'X' & 'ζ' and the residuals for each state 'ε'.

The code was written in R and executed in RStudio. The code for the regressions and local projection frameworks, as well as the dataset, can be found on the author's GitHub repository: github.com/fewfefew/Min-Wage-Paper.git

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