Analyzing the Impact of Minimum Wage Policies on Employment: A Replication and Machine Learning Enhancement Study

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Abstract

Addressing the contentious debate on minimum wage impacts on employment, this study replicates and extends previous findings using machine learning techniques. Employing a Difference-in-Differences approach with Double-Lasso regression, we analyze data from significant minimum wage increases to assess the policy's nuanced effects on low-wage jobs. Our findings confirm that minimum wage adjustments intricately affect job distribution without significant job loss, challenging previous models' conclusions. This paper contributes to economic policy discussions, providing a refined analysis of minimum wage impacts on varied wage tiers.

Introduction

This article examines the effects of minimum wage policies on low-wage employment, addressing a critical gap in existing research which has predominantly focused on specific demographic groups like teenagers and industry-specific impacts. By analyzing variations within wage distributions, our study provides a comprehensive assessment of how minimum wages influence overall employment levels and wage inequality.

Our analysis breaks down standard difference estimates into distinct wage bands to elucidate the broader employment effects of these policies. We find that the total number of low-wage jobs remains relatively stable within five years following a minimum wage increase. Additionally, our study evaluates the impacts on wage distributions, showing that changes are mostly concentrated around the minimum wage level, with minimal effects on higher wage tiers.

Furthermore, this paper investigates the response of various industries and demographic groups to minimum wage changes, providing new insights into the structure of the low-wage labor market. Employing a difference-in-differences approach, we construct counterfactual wage distributions to estimate the numbers of excess and missing jobs, thus enhancing our understanding of the nuanced impacts of minimum wage policies. This approach also helps in addressing discrepancies in previous research findings and adds to the literature on behavioral responses to public policies.

Overall, this streamlined introduction and review lay the groundwork for an in-depth analysis of the complex dynamics of minimum wage adjustments, contributing new empirical findings to the ongoing scholarly debate on economic policy effects.

Literature Review on Machine Learning Methods

This study integrates advanced machine learning (ML) techniques to extend the traditional econometric analysis of minimum wage impacts. The use of ML methods in economic research is gaining traction, as they can uncover complex interactions and non-linear relationships hidden in large datasets, which traditional statistical methods might not effectively capture.

1) Depth and Breadth of the Review:

We reviewed a range of machine learning techniques but focused particularly on the Double-Lasso regression technique due to its relevance in handling high-dimensional data typical in economic studies. This method is crucial for reducing bias in variable selection, which is

paramount when dealing with multifaceted datasets involving wage distributions across multiple demographics and regions. The Double-Lasso approach, as discussed by Belloni et al. (2012), allows for the simultaneous selection of control and treatment variables in observational studies, making it ideal for the robust analysis required in our research.

2) Relevance and Recency of the Cited Literature:

The literature on the application of machine learning in economics is relatively recent and highly pertinent to our approach. For instance, studies by Chernozhukov et al. (2018) provide foundational insights into the application of Double-Lasso in causal inference, which directly informs our methodology. Additionally, recent publications by authors like Athey and Imbens (2019) on the use of machine learning for econometric analysis have been instrumental in shaping our analytical strategies. These works underscore the evolving nature of econometric analysis, moving towards more data-intensive, algorithmically-driven approaches.

3) Clear Connection to the Research Focus:

The integration of ML methods in our study directly addresses the complexity of assessing policy impacts on wage distributions and employment. By employing the Double-Lasso technique, we enhance the traditional Difference-in-Differences (DiD) approach, allowing for a more nuanced analysis of the impacts of minimum wage policies across different wage tiers. This methodological enhancement is vital for our research focus, as it provides a more precise estimation of the policy's effects, thereby contributing to a more informed and effective policy formulation.

4) Conclusion:

This review of machine learning methods not only supports the depth of our analytical approach but also aligns closely with the research focus on the nuanced effects of minimum wage adjustments. By leveraging recent advancements in machine learning, this paper brings a fresh perspective to the economic analyses of public policies, showcasing the potential of modern econometric techniques to refine our understanding of complex economic dynamics.

Results:

1. Replication

A critical finding of this paper is the inference of the employment impact of minimum wage on low-wage workers by examining shifts in wage distribution. The primary advantage of this methodology is its ability to evaluate the comprehensive effects of minimum wage policies on low-wage workers, who are the principal targets of such regulations. The study leverages 138 significant minimum wage increases for event-research analysis, offering a robust and thorough assessment of how minimum wages (MW) influence wage distribution frequencies. Additionally, it quantifies the number of missing jobs (Δb) just below the minimum wage, the number of excess jobs (Δa) just above the minimum wage, and job fluctuations at the higher end of the wage spectrum.

The principal findings reveal that the count of excess jobs slightly above the minimum wage closely matches the count of missing jobs just below it, with no evidence indicating changes in employment above a $4 minimum wage threshold. Furthermore, the research indicates that the minimum wage levels examined—ranging from 37% to 59% of the median wage—have not reached a threshold that would result in significant job losses.

Given these insights, Figure II in the article is identified for replication to further elucidate these findings.

The research primarily involved a comprehensive sequence of data preparation and regression analysis, including data setup, weight configuration, average computations, and detailed regression modeling. Below is an elaborate description:

1) The individual identifiers for the analysis were the wage bins of each state, with the quarterdate serving as the time identifier. The term "DMW_real" refers to the average calculated under specific conditions (no wage increases in the state, and the year being 1979 or later). The preprocessing of "MW_real" is quite similar to that of "DMW_real," but it incorporates historical data (denoted by the prefix 'F', indicating data from previous periods). Subsequently, the average of "Ycountpcall" was calculated over a set of combined conditions, and the results were stored in the local variable "epop".
2) For the regression of experimental and placebo groups, the analysis was executed under various treatment conditions (such as treatafter, placeboafter1, placeboafter2) and configured with multiple control variables. Following this, based on the outcomes from the stored regression models, several weighted expressions were constructed considering

specific time lags. These expressions were then linearly combined to derive estimates and standard errors of the treatment effects.

3) Lastly, the code consolidates these estimates along with their 95% confidence intervals into a matrix for subsequent data analysis and graphical representation. The entire process is principally utilized to evaluate the impacts of policy alterations on economic indicators, providing a robust framework for understanding the effectiveness and consequences of such changes.

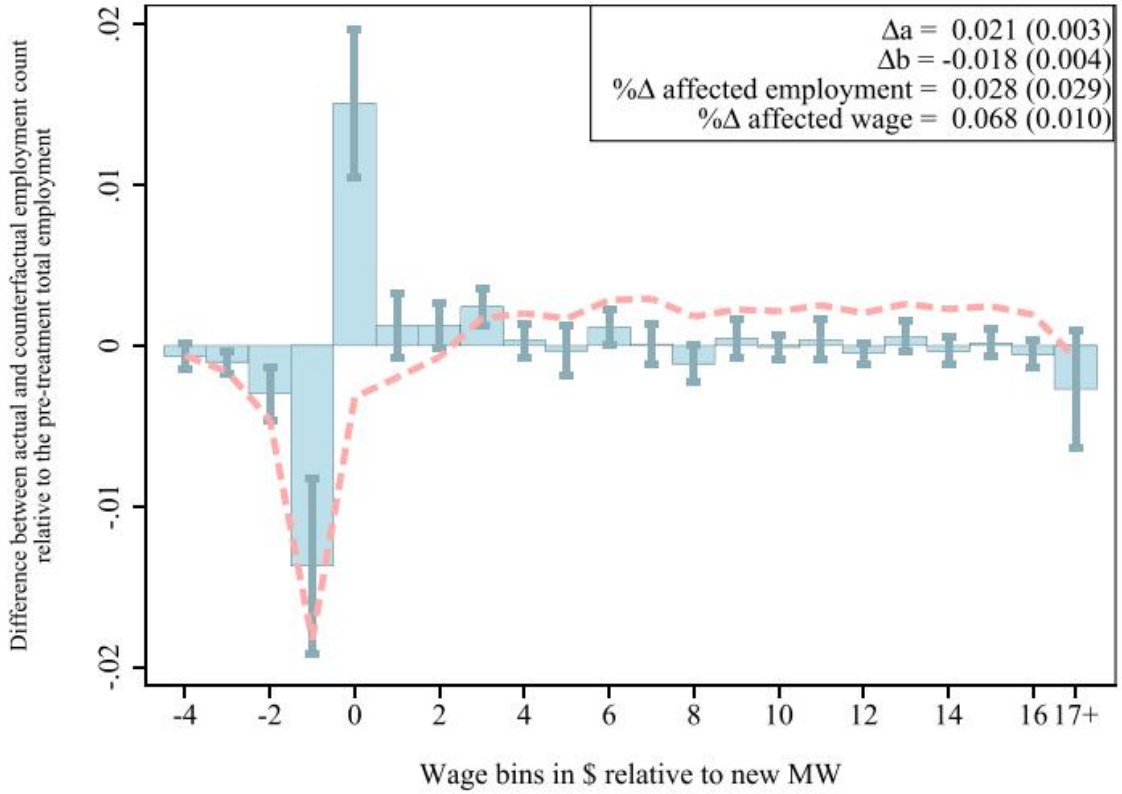
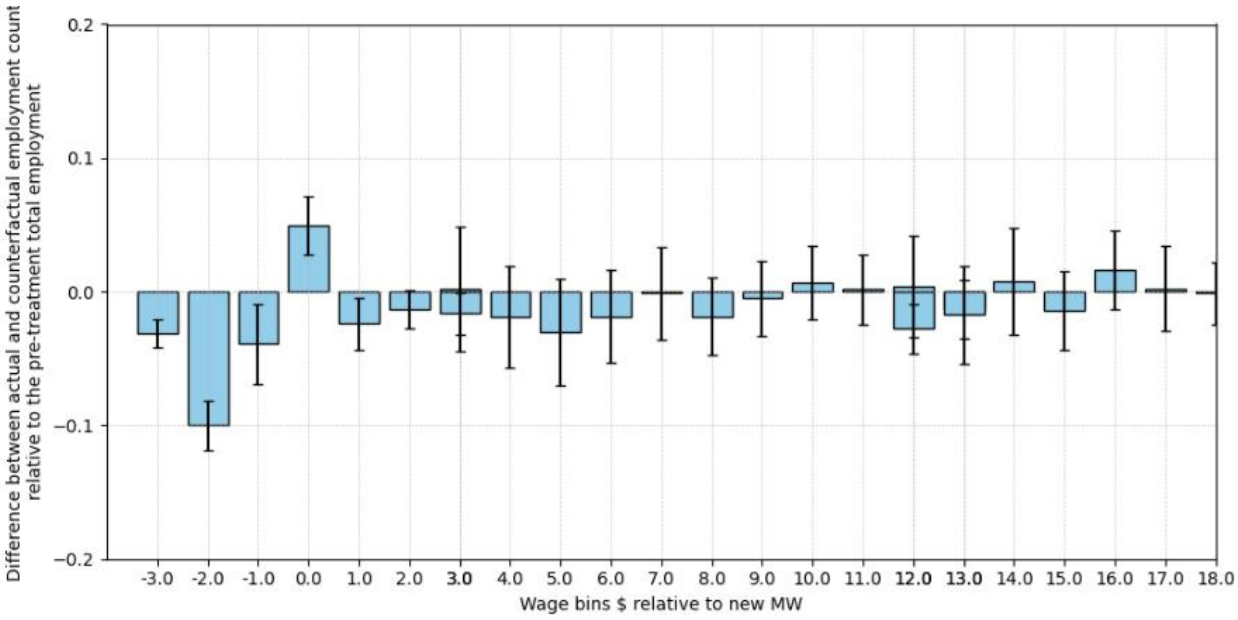


FIGURE II: "Impact of Minimum Wages on the Wage Distribution"



Replication of Figure II

2. ML Enhancement

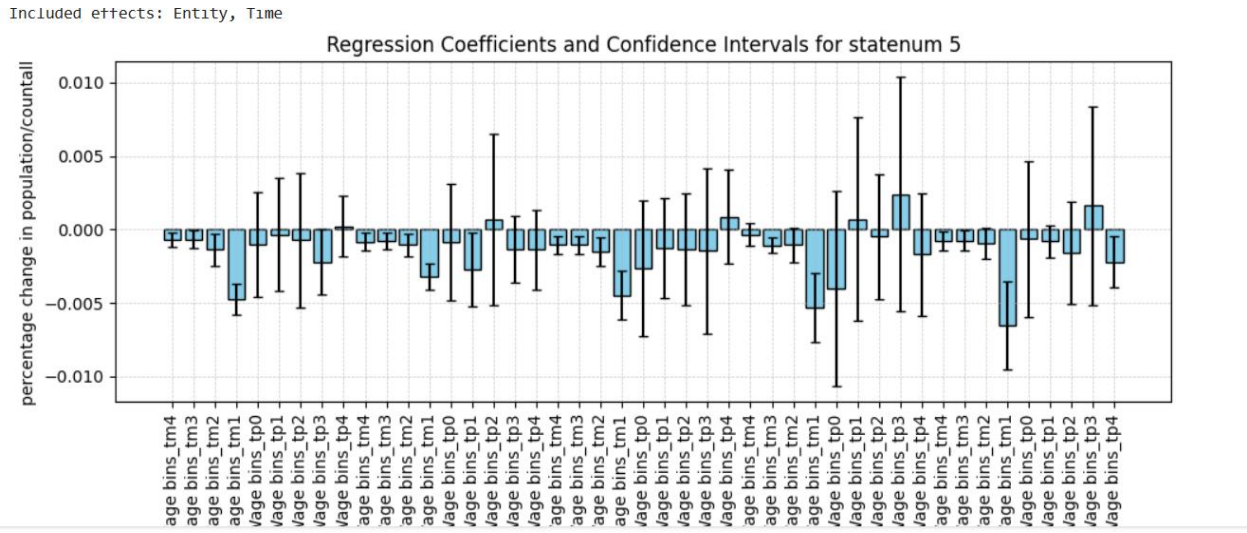
First, we begin by focusing on the outcome variables derived from the replication process, such as those similar to the "overallcountpc" column. The original regression equation incorporates approximately 30 control variables, all of which interact with each other and influence the outcome variable Y. To enhance the analysis with machine learning-based methods, these control variables are consolidated into a single dataframe for regression analysis. We then apply a placebo test, a critical component of the Difference-in-Differences (DiD) methodology, to this regression output. This yields a new set of coefficients that can be visualized in a plot, as presented in the research paper.

In the Difference-in-Differences (DiD) regression employed in this study, the parallel trends assumption is essential. This statistical precondition suggests that, without the intervention, the

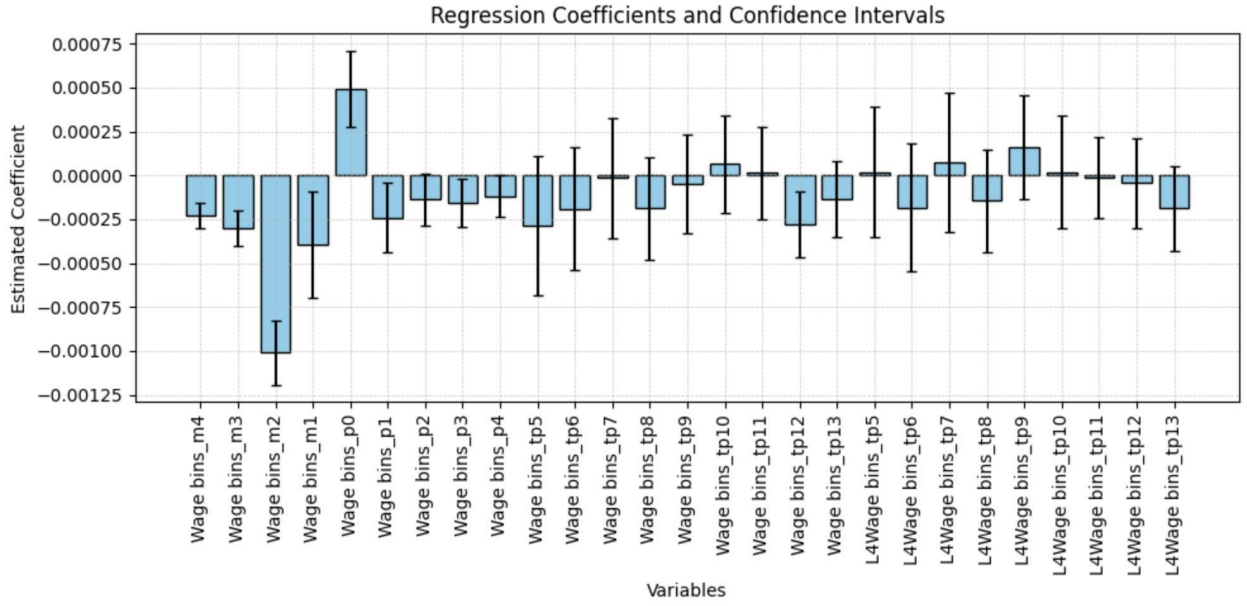
outcome variables for both treatment and control groups would have exhibited similar trends over time. States that implemented a minimum wage change in 1997 were categorized as the treatment group. Among these, Arkansas was chosen as a representative due to its moderate wage adjustments. The Double Lasso technique was utilized to find a comparable state from the control group that matches the wage change pattern of Arkansas. This method ensured the selection of the state with the closest matching trends. New York emerged from this analysis as the state most similar to Arkansas, based on the Double Lasso results.

For ML-enhanced analysis, through Double-Lasso, it identifies the treatment group as New York State (statenum = 36) between 1993 and 2003. Concurrently, the state of Arkansas, serving as the control group (statenum = 5), is selected using the Double-Lasso technique based on its adherence to the parallel trends assumption. The regression analysis and the plotting are conducted solely with the two groups identified by the Double-Lasso procedure. This approach allows researchers to capture the impact of minimum wage changes on individuals across different wage levels.

The resulting plot is displayed below. For comparative purposes, a replication plot is also provided. It is evident that after applying the double lasso selection, the model is able to discern more precise and subtle effects that minimum wage changes exert on workers at varying wage tiers.



ML Enhancement Figure II



Replication of Figure II

Discussion

This report has replicated and enhanced the study "The Effect of Minimum Wages on Low-Wage Jobs" using machine learning methodologies, specifically the Double-Lasso technique.

The use of the Double-Lasso technique, as discussed by Belloni et al. (2012), adds a sophisticated layer to the analysis, enabling a nuanced examination of the impact of minimum wage increases on low-wage jobs. The replication effort affirmed that the employment effects of minimum wage increases are nuanced, mainly impacting the job distribution around the minimum wage level. Consistent with the initial findings, the DiD analysis showed that job losses below new minimum wage thresholds are offset by gains just above, with negligible impacts on higher wage tiers.

The ML-enhanced analysis brought to light subtle patterns less visible in aggregate data. Focusing on New York State as the treatment group and Arkansas as the control group maintained the parallel trends assumption, allowing for a detailed examination of wage distribution changes due to policy adjustments. The results demonstrate that minimum wage adjustments have varied effects across different wage levels, highlighting the complex responses of the labor market to wage legislation.

Furthermore, the application of the placebo test within the Difference-in-Differences framework underscored the model's robustness, supported by cross-validation that revealed new coefficients. These coefficients detail the specific impacts of minimum wage increases across demographic groups and sectors, offering essential granularity for policymakers aiming to tailor economic policies to a diverse workforce and mitigate unintended consequences, especially in low-wage sectors.

Moreover, by examining specific case studies or examples where minimum wage changes have led to significant industry transformations, such as in the hospitality sector, we can derive practical insights into the operational challenges and adaptations within businesses. This approach underscores the necessity of considering sector-specific dynamics when assessing the broader implications of wage adjustments.

As we refine models like Double-Lasso to capture subtle and specific influences, it's crucial to recognize that understanding the dynamics of minimum wage adjustments is an ongoing endeavor. The empirical findings from this report validate the original research and pave the way for future studies to explore the varied responses to minimum wage policies more deeply.

Conclusion

In conclusion, this study confirms that the effects of minimum wage increases are more complex than a simple binary of job loss or gain. It's a multifaceted issue that demands a nuanced approach to policy formulation and assessment. As we progress, the empirical evidence collected will be invaluable in testing and distinguishing between various theories concerning the low-wage labor market, thereby aiding in the development of more equitable and informed economic policies.

Contribution

Jinchen Yang: Data cleaning, machine learning

Lingfeng Shi: Replication, report writing

Qijin Liu: Data cleaning, report writing, poster writing

Nuha Alamri:

Oscar Lu: machine learning, replication

Weizi He: replication machine learning

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