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DOES WAGE THEFT VARY BY DEMOGRAPHIC GROUP? EVIDENCE FROM MINIMUM WAGE INCREASES

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ABSTRACT

Using Current Population Survey data, we assess whether and to what extent the burden of wage theft— wage payments below the statutory minimum wage — falls disproportionately on various demographic groups following minimum wage increases. For most racial and ethnic groups at most ages we find that underpayment rises similarly as a fraction of realized wage gains in the wake of minimum wage increases. We also present evidence that the burden of underpayment falls disproportionately on relatively young African American workers and that underpayment increases more for Hispanic workers among the full working-age population.

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Section I: Introduction

Recent research across a number of contexts has provided evidence that the payment of wages below legally established minimum wages is prevalent.[1] Payment of subminimum wages is common in both high-income and low-income countries (Bhorat *et al.*, 2017; Goraus-Tańska and Lewandowski, 2019; Rani *et al.*, 2013) and has in some settings been shown to disproportionately impact groups including women and temporary workers (Garnero, 2018).

Clemens and Strain (2022a) find that the incidence of subminimum wage payment has risen substantially in the wake of recent increases in the minimum wage in the United States. For each dollar of wage gain realized by workers, underpayment rose by between 12 and 17 cents.[2] In this paper, we assess whether and to what extent the burden of underpayment falls disproportionately on various demographic groups.

For most racial and ethnic groups at most ages we find that underpayment rises similarly as a fraction of realized wage gains in the wake of minimum wage increases. However, we also find evidence that the burden of underpayment may fall disproportionately on relatively young African American workers, for whom we estimate that each dollar in wage gain comes with 20 to 33 cents in additional underpayment, compared to around 14 cents for the population as a whole. For the full population of Hispanic workers, we find evidence of modestly larger

[1] Bhorat *et al*. (2017) find high and highly varying rates of noncompliance across a set of seven countries in sub-Saharan Africa. Two additional studies, one focused on a set of 10 European countries (Goraus-Tańska and Lewandowski, 2019) and one focused on a set of 11 developing countries (Rani *et al*., 2013), find complementary evidence that subminimum wage payment is most prevalent when countries' minimum wage rates are high relative to average wage rates.

[2] Clemens and Strain (2022b) provides evidence that the relationship between minimum wage increases and underpayment as measured in self-reported wage rates is unlikely to be driven by measurement error.

increases in both wage gains and underpayment, such that the change in underpayment per dollar of wage gain is quite similar to what we observe for the non-Hispanic white population.

The remainder of this paper proceeds as follows. Section II describes the data we use in our analysis. Section III describes our empirical methodology and Section IV presents our results. We conclude in Section V with additional discussion of the implications of the findings developed in Section IV.

Section II: Data[3]

In this section we discuss the data sources and variables we use, including wage data, data on minimum wage rates, our measure of underpayment, and macroeconomic data.

Wage data and other variables in the CPS MORG

We analyze data from several sources. Our wage data come from the Current Population Survey (CPS). We use several wage-related variables that are asked of individuals in two out of the eight interviews in which they participate in the CPS. The relevant interviews, during which respondents are asked supplemental questions about their earnings, take place at the end of each of two four-month waves of a respondent's participation. These interviews are collectively known as the Merged Outgoing Rotation Groups (MORG).

We focus one portion of our analysis on individuals ages 16 to 21, as this sample is similar to the typical sample analyzed in studies of the minimum wage's effects on employment.

[3] This section draws heavily from Clemens and Strain (2022a).

We also present results for a broader sample of individuals ages 16 to 65 to obtain estimates of the effects of minimum wage increases on wage gains and underpayment for different demographic groups among the broader working-age population.

Several variables are relevant for estimating an individual's wage rate and for gauging the quality of the underlying data. The first key piece of information is an indicator for whether respondents are paid on an hourly basis. When they are, respondents are asked for their hourly wage rates. When they are not, hourly wage rates can be inferred by dividing an individual's usual weekly earnings by his or her usual weekly hours. While all the relevant information is subject to respondent reporting error, the potential for error will be greater when the hourly wage must be inferred from earnings and hours data because the hourly wage itself is not reported directly. Further, a nontrivial fraction of respondents elects not to report their earnings information when asked. The wage rates for these individuals are therefore imputed. To reduce the potential for errors in the measurement of underpayment, we restrict our analysis samples to individuals who are paid by the hour, do not receive tips, commissions, or overtime pay, and who do not have imputed wage rates.

Effective minimum wage rates

Our data on states' effective minimum wage rates draw on many sources. These include the comprehensive state-by-month minimum wage rates compiled in Clemens, Hobbs, and Strain (2018). These minimum wage rates have been checked against the complementary database of Vaghul and Zipperer (2021). Both databases draw on sources including the U.S. Department of

Labor, the National Conference on State Legislatures, and myriad news articles, reports from state labor departments, and legislative texts.

Subminimum wages and underpayment

For our analysis of subminimum wage payment, we use a continuous measure of the extent to which wage rates fall short of the legislated minimum. This measure, which we term "underpayment," incorporates both the intensive and extensive margins. We set underpayment equal to 0 for individuals who report wage rates equal to or higher than the minimum wage.[4]

Macroeconomic variables

Our analysis incorporates data on macroeconomic covariates that may be relevant as control variables. Specifically, we assess whether macroeconomic conditions are biasing our estimates by tracking indicators of the performance of state-level housing markets, state aggregate income, and labor markets. We proxy for variations in housing markets using a quarterly statewide median house price index from the Federal Housing Finance Agency (FHFA). We proxy for aggregate economic performance using data on quarterly aggregate state income per capita from the Bureau of Economic Analysis (BEA). Finally, we proxy for variations in broader labor market developments using employment among individuals ages 26 to 54 who are less likely affected by changes in the minimum wage. As shown in Clemens and

[4] This definition of underpayment is identical to that used in Clemens and Strain (2022a). In addition to the continuous measure of underpayment, that paper also defines "subminimum wage payment" as a binary indicator for whether an individual's hourly wage rate is more than $0.25 below the minimum wage.

Strain (2018), minimum wage increases tended, over this time period, to be enacted by states that experienced strong macroeconomic conditions.

Section III: Estimation Methods

In this section, we present the empirical models we estimate.

We first present difference-in-differences style analyses using continuous variation in states' minimum wage rates. The basic specification is presented in equation (1) below:

$$S_{i,s,t} = \beta_1 MW_{s,t} + \alpha_{1s} State_s + \alpha_{2t} Time_t + X_{i,s,t}\gamma + \varepsilon_{i,s,t}. \qquad (1)$$

Following Clemens and Strain (2022a), for our primary analyses $S_{i,s,t}$ is a either the reported hourly wage or a continuous measure of underpayment for individual *i*, living in state *s*, in time period *t*. The continuous measure of underpayment is defined as the difference between the state minimum wage rate and an individual's reported hourly wage. For individuals paid at or above the state minimum wage rate, we set this value to zero.

Like any standard difference-in-differences specification, equation (1) controls for sets of state and time fixed effects. The vector *X* contains sets of control variables that vary across specifications. In our most-controlled specification, it contains the median house price index, the log of aggregate personal income per capita, state employment rates among individuals ages 26 to 54, and individual-level demographic characteristics. In light of recent methodological insights (Caetano *et al.*, 2022), specifications with time varying controls are always complemented by a comparable specification that excludes such controls.

Our primary interest in the present analysis is in testing for differences across demographic groups in the extent to which underpayment rises in the wake of minimum wage increases. Using the framework described by equation (1), we thus take two steps. First, we estimate equation (1) itself on the demographic sub-samples of interest. Comparing estimates of β_1 estimated using various sub-samples provides a transparent look at the extent to which minimum-wage induced changes in underpayment vary across demographic groups. Second, we generate a more direct statistical test for such differences by estimating an "interacted" specification using our full analysis sample. That is, we augment equation (1) with sets of interactions between the minimum wage and indicators for the demographic groups of interest. Because we exclude an interaction term for non-Hispanic white workers, the coefficients on other interaction terms can be interpreted as the difference between the change in underpayment experienced by a given group relative to the change experienced by non-Hispanic white workers.

To gauge how the timing of changes in underpayment relates to the timing of minimum wage increases, we also implement a set of event study specifications.[5] The stacked event study estimator we use is described by equation (2).

$$S_{i,s,g,c,t,p(s,t)} = \sum_{g \neq 0} \sum_{p(s,t) \neq 0} \beta_{g,p(s,t)} Policy_{g(s)} \times Time_{p(s,t)} + \alpha_{1s,c}\, State_{s,c} + \alpha_{2t}\, Time_t + X_{i,s,t}\, \gamma + \varepsilon_{i,s,t}. \quad (2)$$

[5] Recently, a growing set of papers have shown that a so-called "traditional" event study estimator can produce biased estimates when policy changes are staggered in time and when treatment effects are heterogeneous (Baker, Larcker, and Wang, 2022; Borusyak, Jaravel, and Spiess, 2021; Callaway and Sant'Anna, 2021; Gardner 2021; Goodman-Bacon, 2021; Liu, Wang, and Xu, forthcoming). We thus present results from two of the more recently proposed estimators, namely the "stacked event study" estimator and an "imputation" estimator. The latter has been proposed and developed by authors including Gardner (2021), Liu, Wang, and Xu (forthcoming), and Borusyak, Jaravel, and Spiess (2021), while the former has gained currency in minimum wage studies from its use as a robustness check by Cengiz *et al.* (2019). As in Clemens and Strain (2021; 2022a), all event-study estimators use data from 2010 to 2019. The addition of 2010 data to the sample aids our ability to assess the potential relevant of divergent pre-existing trends.

The equation is estimated on a data set constructed through the following steps. First, we create separate, event-by-cohort-specific data sets for each policy cohort, by which we refer to the group of states that implemented their first statutory minimum wage increase during a particular year. Each cohort-specific data set consists of the relevant policy cohort plus the set of control states that implemented no minimum wage changes across the duration of our sample. Within each cohort-specific data set, we define "event time" relative to the year in which the policy cohort implemented its first statutory minimum wage changes. We then append (or "stack") these policy-cohort data sets on top of one another. The stacked data set thus contains replicates of the observations from the "never treated" control groups. As discussed by Baker, Larcker, and Wang (2022), a relevant difference in the stacked event study estimator in equation (2) relative to a standard event study estimator is the addition cohort-by-state effects to account for the multiple appearances of observations from the never-treated control states, in which the observations from these states are associated with different time periods, *p(s,t)*, relative to the year in which a given policy cohort implemented its statutory minimum wage increases.

Equation (2) differs from equation (1) with respect to the manner in which we include policy variation in states' minimum wage regimes in the specification. Whereas equation (1) uses a continuous measure of the minimum wage, equation (2) uses event-time indicator variables, which are set with reference to the enactment of a state's first minimum wage increase due to legislation enacted during the sample.[6] We omit the interaction for the time period describing the year prior to the first minimum wage in increase, which we define as year $p(s,t) = 0$. The

[6] We present a list of states with no minimum wage changes during our sample period, as well as the year of first increase for the states implementing statutory increases, in Appendix Table A2. Note that for both the time series tabulations presented in Figure 1 and for our event study analyses, we do not include as treatment states the small set of states that implemented a first minimum wage increase as a result of new legislation passed in last three years of our sample. This follows the analysis in Clemens and Strain (2022a), which was in turn adhering to a grouping of states adopted in an earlier paper (Clemens and Strain, 2021) in which the groupings were bound by a pre-analysis plan. The grouping of states for the time series tabulations presented in Figure 1 is shown in Appendix Table A1.

coefficients of interest can thus be interpreted as differential changes in underpayment from the year prior to the first minimum wage increase to the reference year. For reference years less than 0, the point estimates thus provide evidence on whether divergent trends in underpayment had occurred prior to the minimum wage increase's enactment. Estimates for years following the minimum wage increase track the dynamics with which underpayment subsequently evolved.

In addition to the "stacked event study" estimator, we present "imputed causal effects" estimates that utilize methods proposed and developed by authors including Gardner (2021), Liu, Wang, and Xu (forthcoming), and Borusyak, Jaravel, and Spiess (2021). The "imputed causal effects" approach involves an intuitive, multi-step procedure. First, state fixed effects, time effects, and coefficients on time varying covariates are estimated on untreated observations.[7] Second, the counterfactual outcome for each treated observation is "imputed" using the coefficients from step one. Finally, treatment effects are estimated by comparing the realized and counterfactual outcomes for treated units. Note that this procedure straightforwardly gives rise to "dynamic" treatment effect estimates like those from the stacked event study estimator if the treatment effects are averaged separately for observations that occur one year after the treatment event, two years after the treatment event, three years after the treatment event, and so on.[8]

Section IV: Analysis of Underpayment on the Margin

In this section we present results from the analyses described above. After presenting

[7] Note that this set of observations includes all observations from "never treated" states as well as pre-treatment observations from states that eventually implement a minimum wage increase during our analysis sample.
[8] Borusyak, Jaravel, and Spiess (2021) also provide techniques for generating tests for the presence of divergent pre-existing trends as well as for computing standard errors within the "imputed causal effects" framework.

simple time series tabulations, we present regression estimates of equations (1), and (2).

Initial evidence on the evolution of underpayment across minimum wage regimes

Figure 1 provides a graphical look at the data underlying our analysis. The figure reports time series separately for the policy groups we categorize as "no changers" for observations in states without a change in the minimum wage, "statutory" for observations from states that enacted minimum wage increases through new legislation, and "indexers" for observations from states whose minimum wage increased due to inflation-indexing provisions. We discuss these categories further in Appendix Table A1.

Figure 1 presents data on the average amount of underpayment experienced by individuals who are employed, paid hourly, do not receive tips, commissions, or overtime pay, and do not have imputed wage rates. The sample in Panel A contains African American workers ages 16 to 21. The sample in Panel B contains African American workers ages 16 to 65. The sample in Panel C contains Hispanic workers ages 16 to 21. The sample in Panel D contains Hispanic workers ages 16 to 65. The sample in Panel E contains white workers ages 16 to 21. The sample in Panel F contains white workers ages 16 to 65. Several facts are notable in these series. First, as shown previously in Clemens and Strain (2022a), overall rates of underpayment rose over the course of decade in states that increased their minimum wage rates, but not in states that did not increase their minimum wage rates. Second, both the baseline level of underpayment and the rise in underpayment is much larger for young workers than for the broader working-age population. Third, young African American workers appear to have experienced a particularly large increase in underpayment in states that increased their minimum wage rates. Fourth,

Hispanic workers ages 16 to 65 appear to have experienced larger increases in underpayment than African American or white workers.

Regression estimates of the impacts of minimum wage increases on wages and underpayment

This section presents regression estimates of the extent to which the incidence of underpayment expands as the minimum wage rises for different demographic groups.

Table 1 presents estimates of equation (1) for different demographic groups. We estimate both the increase in underpayment and the increases in wages received per dollar of minimum wage increase for workers ages 16 to 21 or 16 to 65.[9] Columns 1 and 2 present estimates for all workers, Columns 3 and 4 restrict the sample to African American workers who are not Hispanic, Columns 3 and 4 focus on Hispanic workers, Columns 7 and 8 focus on foreign-born or other race workers, and Columns 9 and 10 restrict the sample to non-Hispanic white workers. Panels A and B present results for individuals ages 16 to 21; Panel A excludes controls for variations in house prices, income per capita, and employment, while Panel B includes them. Panels C and D present results for individuals ages 16 to 65; Panel C excludes controls for variations in house prices, income per capita, and employment, while Panel D includes them.

We find that minimum wage increases lead to both increases in hourly wages and increases in measured underpayment across all of the demographic groups we analyze, with the effects on wage gains and underpayment being most intensively concentrated among younger workers. Including state-level controls, we estimate that a one-dollar increase in the minimum

[9] To prevent the estimated wage gains from being driven by wage values that could not plausibly be affected by the minimum wage, we censor our hourly wage variable at $15. This moderately reduces the estimated wage increase in some specifications.

wage leads to an increase in hourly wages for workers ages 16 to 21 that ranges from 28.3 to 44.9 cents across groups. The accompanying increases in underpayment range from 4.0 to 9.4 cents. The estimated increase in underpayment amounts to 13.8 percent of realized wage gains for the full sample of workers ages 16 to 21, with the shares ranging from 8.9 percent for workers in our foreign-born and "other" category to 33.2 percent for young African American workers. For the broader sample of workers ages 16 to 65, a one-dollar increase in the minimum wage leads to wage gains ranging from 8.6 to 15.6 cents across groups. The accompanying increases in underpayment range from of 1.5 to 2.5 cents. The estimated increase in underpayment amounts to 16.5 percent of realized wage gains for the full sample of workers ages 16 to 65.

In Table 2, we more directly test for differences in underpayment across groups. To do so, we estimate differential impacts of minimum wage increases on underpayment by pooling across racial and ethnic groups while "fully saturating" the specification with interactions between indicators for each demographic sample and the effective minimum wage as well as all other variables described in equation (1). The coefficient on "effective minimum wage" measures the effect of minimum wage increases on non-Hispanic white workers and the coefficients on the interaction terms measure the effects on other groups relative to non-Hispanic white workers. In Panel A, we present results for hourly wages and underpayment, and in Panel B, we test whether the differences between demographic groups are statistically significant. We observe that African American workers ages 16 to 21 experience significantly more underpayment than 16 to 21 year old white workers in the wake of minimum wage increases. On the broader sample of individuals ages 16 to 65, Hispanic workers experience more underpayment than white workers.

Appendix Tables A3 and A4 present evidence on a potential mechanism behind variations in the degree of underpayment on the margin. In particular, we augment the specifications presented in Tables 1 and 2 with sets of industry fixed effects.[10] If we were to estimate smaller differences across groups in these specifications, we would include that the variations we have estimated are linked, at least in part, to the industries in which members of different groups tend to be employed. This is not what we find, however, as the estimates are economically very similar to the estimates reported in Tables 1 and 2. Differences in the degree of underpayment on the margin across demographic groups thus appear to prevail even among workers in the same industry.

We next explore how patterns of underpayment evolved dynamically for African American workers, Hispanic workers, and white workers in the wake of statutory minimum wage increases. Figures 2 and 3 present the estimates, with Figure 2 presenting estimates for individuals ages 16 to 21 and Figure 3 presenting estimates for individuals ages 16 to 65. In each figure, Panel A presents estimates from the stacked event study estimator while Panel B presents estimates using the imputed causal effects approach. The outcome in these analyses is the level of underpayment measured in dollars.[11]

While estimates are naturally noisier for smaller demographic groups than for larger demographic groups, none of the estimates in any of the panels raise concerns regarding the relevance of divergent pre-existing trends across states. All estimates for all groups, using both the stacked event study and imputed causal inference methods, are statistically distinguishable

[10] For the industry codes, we use *dind02* from the NBER CPS MORG, which is an NBER created 2-digit NAICS-based Detailed Industry Classification Code that is consistent over all the years in our sample.
[11] We omit the "indexer" states from the event studies in Figures 2 and 3 because their first minimum wage increases occurred in 2011 or 2012 which is near the start of our sample period.

from 0 in all years preceding the enactment of a state's first minimum wage increase during our sample. The dynamic effects we estimate are consistent with the estimates presented in Tables 1 and 2. For individuals ages 16 to 21, the rise in underpayment in the wake of statutory minimum wage increases tends to be non-trivially larger in magnitude for African American workers than for white workers, although the point estimates tend not, in these estimation frameworks, to be statistically distinguishable from one another. For the broader sample of individuals ages 16 to 65, the greatest incidence of underpayment appears to affect Hispanic workers, just as in the analyses presented in Tables 1 and 2. In the event study analysis, this difference emerges rather dramatically towards the end of the sample and is not apparent in the initial years following the implementation of a state's first minimum wage increase.

An additional notable fact from these event study analyses is that the extent of underpayment tends to rise over time following the enactment of a state's first minimum wage increase. As further analyzed in Clemens and Strain (2022a), this is likely because states' initial minimum wage increases tended, over the period we analyze, to be followed by additional minimum wage increases.[12]

Section VI: Discussion and Conclusion

In this paper, we examine how changes in underpayment following minimum wage increases are distributed across demographic groups defined according race, ethnicity, and age.

[12] In a piece of analysis reported in an appendix, Clemens and Strain (2022a) focus on the small set of states whose minimum wages stopped ratcheting up mid-way through the 2010s. The evidence from this small set of states is consistent with the view that firms gradually adjust to become compliant with the new minimum wage. Evidence from other contexts (e.g., Germany) similarly suggests that non-compliance may be heightened in the short run (Caliendo *et al.*, 2018; Bruttel, Baumann, and Dütsch, 2018).

Using Current Population Survey data, we find evidence that the incidence of underpayment rises substantially for workers across all racial and ethnic groups, in particular among the young, in the wake of minimum wage increases. Consistent with evidence in Clemens and Strain (2022a), the overall rise in the underpayment in the wake of minimum wages is equivalent to between 10 and 20 percent of realized wage gains across the full sample.

In addition, we find evidence of two sources of heterogeneity in the rise in underpayment experienced by members of different racial and ethnic groups. Among young workers (those ages 16 to 21), we find evidence that the burden of underpayment falls disproportionately on African American workers. Underpayment may thus blunt the impact of minimum wage increases on wage gaps between young African American workers and other groups of young workers. Among the broader sample of individuals ages 16 to 65, we find that Hispanic workers experience a greater increase in the incidence of underpayment than do non-Hispanic white workers. Here again, underpayment would thus appear to blunt the impact of minimum wage increases on measured wage gaps between Hispanic and non-Hispanic workers.

It is an open question what impact an increase in minimum wage enforcement would have on workers who experience underpayment. On the one hand, enforcement's mechanical impact would be to increase their wages. On the other hand, prior research has discussed and provided evidence for the hypothesis that evasion may be a strategy through which firms seek to absorb the cost shock from minimum wage increases while laying off as few workers as possible (Garnero and Lucifora, 2022; Badaoui and Walsh, 2022; Clemens, 2021).[13] This highlights a potential trade-off between enforcement, on the one hand, and firm responses that might more

[13] A conceptually related line of work has found that the minimum wage interacts with tax compliance and that tax-evading firms may, by increasing their reporting rates, room to comply with minimum wages without actually increasing net pay (Tonin, 2011; 2013; Gavoille, and Zasova, 2021).

negatively impact a minimum wage increase's intended beneficiaries. We raise this trade-off as an important area for future research.

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Tables and Figures

Table 1. Relationship Between Minimum Wage Increases, Average Hourly Wage Increases, and Underpayment Among Individuals Ages 16-21 or Ages 16-65 by Race, Ethnicity, and Nativity Using Continuous Minimum Wage Variation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Sample	Full Sample		Non-Hispanic African American		Hispanic		Foreign and Other		Non-Hispanic White	
Dependent Variable	Hourly Wage	Underpayment	Hourly Wage	Underpayment	Hourly Wage	Underpayment	Hourly Wage	Underpayment	Hourly Wage	Underpayment
					Panel A: Ages 16-21 No Macro Controls					
Effective Minimum Wage	0.432***	0.050***	0.385***	0.078**	0.446***	0.054***	0.525***	0.045***	0.402***	0.052***
	(0.030)	(0.004)	(0.110)	(0.029)	(0.027)	(0.008)	(0.049)	(0.008)	(0.030)	(0.006)
					Panel B: Ages 16-21 With Macro Controls					
Effective Minimum Wage	0.384***	0.053***	0.283***	0.094***	0.389***	0.059***	0.449***	0.040***	0.378***	0.051***
	(0.036)	(0.005)	(0.105)	(0.023)	(0.053)	(0.013)	(0.068)	(0.010)	(0.036)	(0.007)
Observations	52,065	52,065	3,765	3,765	7,583	7,583	6,700	6,700	34,017	34,017
					Panel C: Ages 16-65 No Macro Controls					
Effective Minimum Wage	0.115***	0.018***	0.093**	0.013	0.119***	0.027***	0.118***	0.022***	0.072**	0.014***
	(0.016)	(0.003)	(0.036)	(0.008)	(0.019)	(0.004)	(0.019)	(0.003)	(0.027)	(0.002)
					Panel D: Ages 16-65 With Macro Controls					
Effective Minimum Wage	0.103***	0.017***	0.105*	0.015	0.156***	0.025***	0.086**	0.019***	0.089***	0.015***
	(0.024)	(0.003)	(0.054)	(0.010)	(0.034)	(0.005)	(0.034)	(0.003)	(0.025)	(0.003)
Observations	409,121	409,121	34,320	34,320	34,186	34,186	83,879	83,879	256,736	256,736

Notes: This table reports regression results examining the effect of minimum wage increases on average hourly wages and underpayment for different samples of workers. The dependent variable is an individual's reported hourly wage in Columns 1, 3, 5, and 7, and the amount of reported underpayment for individuals with reported hourly wages below the effective minimum wage in Columns 2, 4, 6, and 8. The sample is from the CPS MORG and consists of individuals ages 16-21 (Panels A and B) or 16-65 (Panels C and D) who are employed; paid by the hour; do not receive overtime tips or commissions; and do not have imputed wage rates. Columns 1 and 2 display estimates of the effect of minimum wage changes on average hourly wages and underpayment among all individuals ages 16-21 or 16-65, Columns 3 and 4 display estimates of the effect of minimum wage changes on average hourly wages and underpayment among native-born, non-Hispanic African Americans, Columns 5 and 6 display estimates of the effect of minimum wage changes on average hourly wages and underpayment among Hispanics, Columns 7 and 8 display estimates of the effect of minimum wage changes on average hourly wages and underpayment among foreign-born and other individuals, and Columns 9 and 10 display estimates of the effect of minimum wage changes on average hourly wages and underpayment among native-born, non-Hispanic whites. All specifications include month, year, month-year, and state fixed effects, as well as dummy variables for each education group and age. The specifications with "macro controls" reported in Panels B and D also include controls for state quarterly house prices, quarterly income per capita, and monthly prime-age employment. Standard errors are clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1

Table 2. Relationship Between Minimum Wage Increases, Average Hourly Wage Increases, and Underpayment Among Individuals Ages 16-21 and 16-65 by Race, Ethnicity, and Nativity Using Continuous Minimum Wage Variation and Fully Saturated Regression Specification

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sample	Ages 16-21		Ages 16-21		Ages 16-65		Ages 16-65	
Dependent Variable	Hourly Wage	Underpayment	Hourly Wage	Underpayment	Hourly Wage	Underpayment	Hourly Wage	Underpayment
Panel A: Regression Results Sample X Wage Interaction								
Effective Minimum Wage	0.402***	0.052***	0.378***	0.051***	0.072**	0.014***	0.089***	0.015***
	(0.031)	(0.006)	(0.036)	(0.007)	(0.027)	(0.002)	(0.025)	(0.003)
Effective Minimum Wage X African American	-0.016	0.026	-0.094	0.043*	0.021	-0.001	0.016	0.001
	(0.098)	(0.029)	(0.095)	(0.021)	(0.032)	(0.008)	(0.048)	(0.008)
Effective Minimum Wage X Hispanic	0.045	0.002	0.011	0.008	0.047**	0.013***	0.067	0.010*
	(0.036)	(0.011)	(0.056)	(0.015)	(0.021)	(0.004)	(0.041)	(0.006)
Effective Minimum Wage X Foreign-Born	0.124**	-0.006	0.071	-0.012	0.046	0.008**	-0.003	0.004
	(0.048)	(0.008)	(0.062)	(0.011)	(0.031)	(0.003)	(0.030)	(0.003)
Ln(Income per Capita)			0.709	-0.026			-0.155	-0.002
			(0.943)	(0.247)			(0.642)	(0.067)
House Price Index / 1000			0.512	0.018			-0.569	-0.016
			(0.701)	(0.196)			(0.710)	(0.065)
State prime-age emp-to-pop ratio			-0.067	0.018			0.434**	-0.026
			(0.445)	(0.079)			(0.194)	(0.028)
Panel B: Differences of Coefficients in Panel A								
African American - Hispanic	-0.061	0.024	-0.106	0.035	-0.025	-0.014	-0.051	-0.010
	(0.108)	(0.032)	(0.112)	(0.026)	(0.038)	(0.010)	(0.064)	(0.010)
African American - Foreign	-0.140*	0.033	-0.166*	0.055**	-0.025	-0.008	0.019	-0.004
	(0.083)	(0.031)	(0.083)	(0.023)	(0.032)	(0.009)	(0.047)	(0.009)
African American - White	-0.016	0.026	-0.094	0.043*	0.021	-0.001	0.016	0.001
	(0.098)	(0.029)	(0.095)	(0.021)	(0.032)	(0.008)	(0.048)	(0.008)
Hispanic - Foreign	-0.079	0.009	-0.060	0.020	0.000	0.005	0.070	0.006
	(0.051)	(0.012)	(0.070)	(0.019)	(0.029)	(0.004)	(0.048)	(0.006)
Hispanic - White	0.045	0.002	0.011	0.008	0.047**	0.013***	0.067	0.010*
	(0.036)	(0.011)	(0.056)	(0.015)	(0.021)	(0.004)	(0.041)	(0.006)
Foreign - White	0.124**	-0.006	0.071	-0.012	0.046	0.008**	-0.003	0.004
	(0.048)	(0.008)	(0.062)	(0.011)	(0.031)	(0.003)	(0.030)	(0.003)
Observations	52,065	52,065	52,065	52,065	409,121	409,121	409,121	409,121

Notes: This table reports regression results from the fully saturated model examining the effect of minimum wage increases on average hourly wages and underpayment for different samples of workers. The dependent variable is an individual's reported hourly wage in Columns 1, 3, 5, and 7, and the amount of reported underpayment for individuals with reported hourly wages below the effective minimum wage in Columns 2, 4, 6, and 8. The sample is from the CPS MORG and consists of individuals who are employed; paid by the hour; do not receive tips, commissions, or overtime; and do not have imputed wage rates. Columns 1-4 display estimates of the effect of minimum wage changes on average hourly wages and underpayment among all individuals ages 16-21, and Columns 5-8 display estimates of the effect of minimum wage changes on average hourly wages and underpayment among individuals 16-65. Variable definitions and sources are discussed in the note to Table 2 (and in the paper). All specifications include month, year, month-year, and state fixed effects, as well as dummy variables for each education group and age. Standard errors are clustered at the state level. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

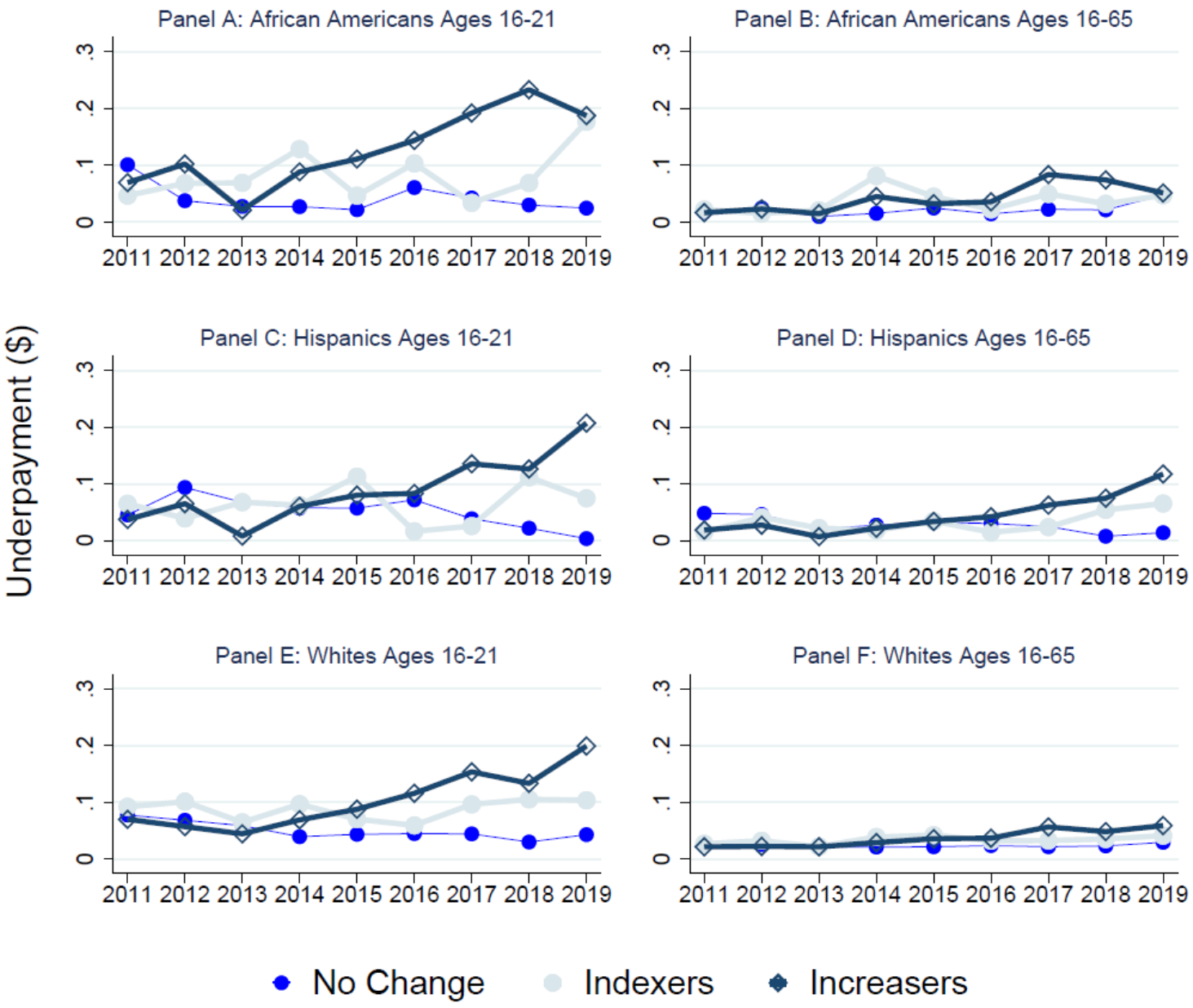

Figure 1. Average Underpayment by Demographic Group Across Minimum Wage Policy Categories. This figure plots the average underpayment for each of our 3 minimum wage policy groups, broken out across demographic subsamples, from 2011 to 2019. Data come from the Current Population Survey Merged Outgoing Rotation Groups (CPS MORG) and include individuals who are employed; paid by the hour; do not receive overtime, tips, or commissions; and do not have imputed wage rates. Panel A includes African Americans ages 16-21. Panel B includes African Americans ages 16-65. Panel C includes Hispanics ages 16-21 Panel D includes Hispanics ages 16-65. Panel E includes whites ages 16-21. Panel F includes whites ages 16-65. States are defined as statutory increasers if they had at least one statutory minimum wage increase between January 2013 and January 2015. Indexers are states that index their minimum wage to inflation. Averages are weighted by state population.

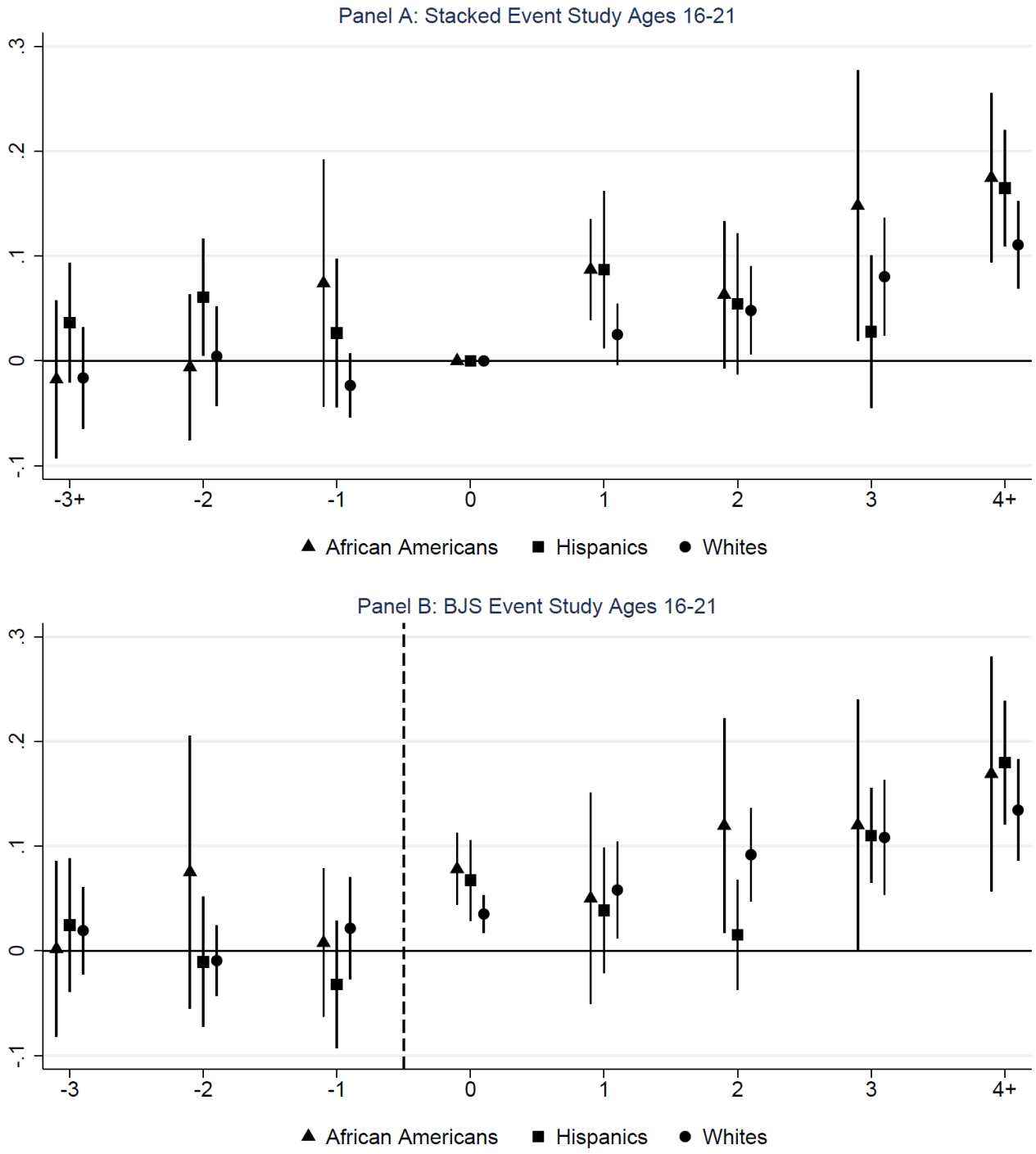

Figure 2. Event Studies of Changes in Underpayment For African Americans, Hispanics, and Whites Ages 16-21 Following Initial Statutory Minimum Wage Increases Using Various Event Study Estimators. This figure displays coefficients obtained from different event study estimators. Panel A displays results for African Americans, Hispanics and non-Hispanic whites using the stacked event study estimator. Panel B displays results for African Americans, Hispanics, and non-Hispanic whites using the imputation estimator proposed by Borusyak, Jaravel, and Spiess (2021) (BJS). For all panels, the sample consists of all individuals ages 16-21 from the CPS MORG who are employed; paid by the hour; do not receive overtime, tips, or commissions; and do not have imputed wage rates. Estimates for statutory increases are plotted for "event" years ranging from 3 or 4 years before to 4 or 5 years after a state's first statutory minimum wage increase occurred. The year of the initial increase is period 1 for the standard and stacked estimators in Panel A, and period 0 for the BJS estimator in Panel B. Error bars denote 95 percent confidence intervals around each estimated coefficient. Standard errors are clustered by state.

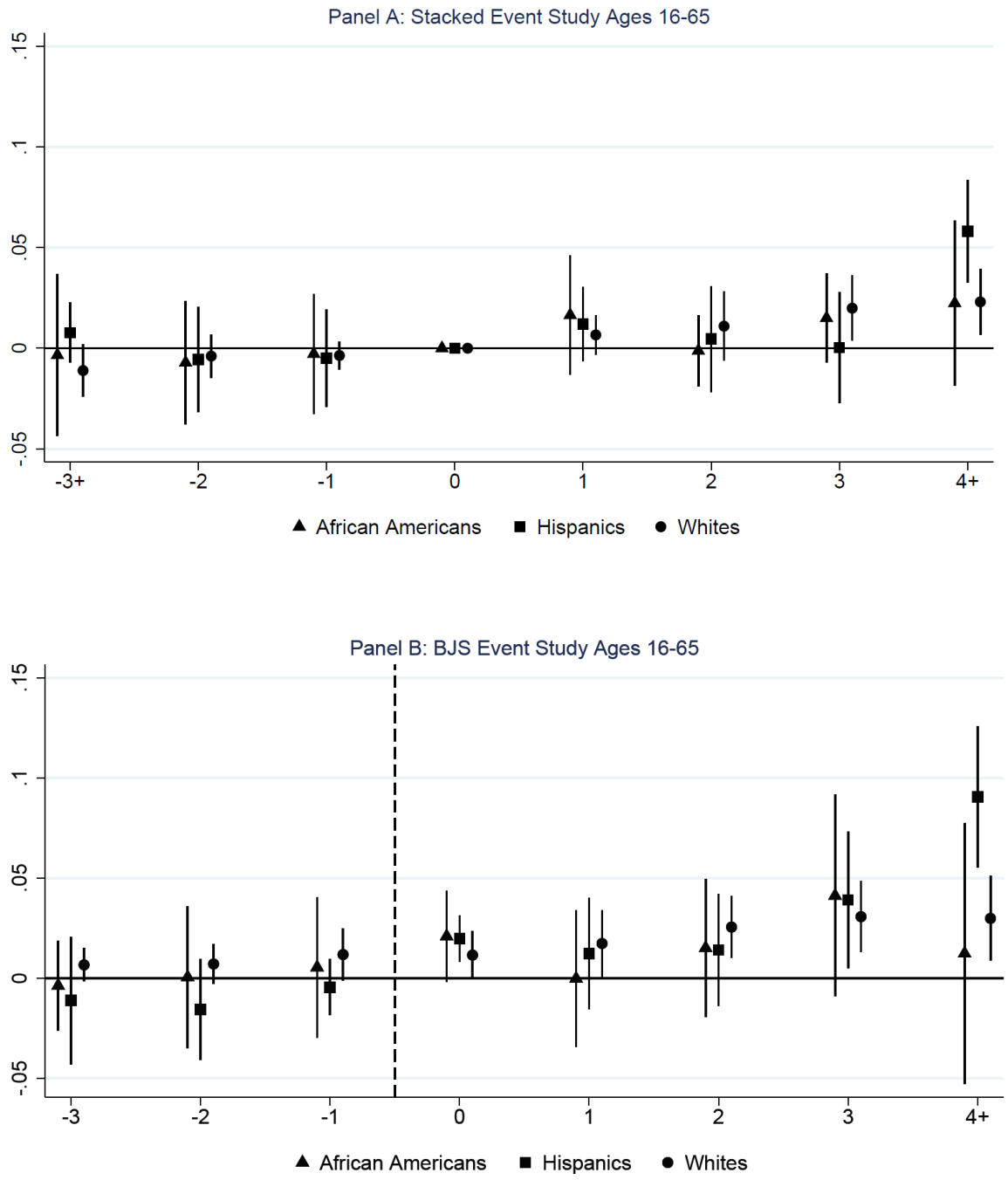

Figure 3. Event Studies of Changes in Underpayment For African Americans, Hispanics, and Whites Ages 16-65 Following Initial Statutory Minimum Wage Increases Using Various Event Study Estimators. This figure displays coefficients obtained from different event study estimators. Panel A displays results for African Americans, Hispanics, and non-Hispanic whites using the stacked event study estimator. Panel B displays results for African Americans, Hispanics, and non-Hispanic whites using the imputation estimator proposed by Borusyak, Jaravel, and Spiess (2021) (BJS). For all panels, the sample consists of all individuals ages 16-65 from the CPS MORG who are employed; paid by the hour; do not receive overtime, tips, or commissions; and do not have imputed wage rates. Estimates for statutory increases are plotted for "event" years ranging from 3 or 4 years before to 4 or 5 years after a state's first statutory minimum wage increase occurred. The year of the initial increase is period 1 for the standard and stacked estimators in Panel A, and period 0 for the BJS estimator in Panel B. Error bars denote 95 percent confidence intervals around each estimated coefficient. Standard errors are clustered by state.

Appendix Tables and Figures

Table A1. List of States with Statutory Minimum Wage Increases and Inflation-Indexed Increases Using Changes from 2013 to 2015 and $1 Cutoff

Statutory increasers of $1 or more	Statutory increasers under $1
Alaska	Arkansas
California	Connecticut
District of Columbia	Delaware
Massachusetts	Hawaii
New Jersey	Maryland
New York	Michigan
Rhode Island	Minnesota
South Dakota	Nebraska
	West Virginia
Indexers	
Arizona	
Colorado	
Florida	
Missouri	
Montana	
Ohio	
Oregon	
Vermont	
Washington	

Notes: Data on minimum wage indexing provisions comes from the National Council of State Legislatures. The states labeled as Indexers link annual updates to their effective minimum wage rates to a measure of inflation. Data on minimum wage changes comes from the U.S. Department of Labor. States are counted as statutory increasers of under $1 if the combined statutory increase in the minimum wage from January 1, 2013 through January 1, 2015 was under $1. States are counted as statutory increasers of $1 or more if the combined statutory increase in the minimum wage was $1 or more.

Table A2. List of States with Statutory Minimum Wage Increases and the Year of First Increase Using Changes from 2013 to 2015

No Minimum Wage Change	Statutory Increasers	Year of First Statutory Increase
Alabama	Alaska	2015
Georgia	Arkansas	2015
Idaho	California	2014
Illinois	Connecticut	2014
Indiana	Delaware	2014
Iowa	District of Columbia	2014
Kansas	Hawaii	2015
Kentucky	Maryland	2015
Louisiana	Massachusetts	2015
Maine	Michigan	2014
Mississippi	Minnesota	2014
Nevada	Nebraska	2015
New Hampshire	New Jersey	2014
New Mexico	New York	2014
North Carolina	Rhode Island	2013
North Dakota	South Dakota	2015
Oklahoma	West Virginia	2015
Pennsylvania		
South Carolina		
Tennessee		
Texas		
Utah		
Virginia		
Wisconsin		
Wyoming		

Notes: Data on minimum wage changes comes from the U.S. Department of Labor. States are counted as having no minimum wage changes if there minimum wage did not change between January 1, 2011 and January 1, 2015. States are counted as statutory increasers if they had at least one minimum wage change between January 1, 2013 and January 1, 2015 that was the result of new legislation.

Table A3. Relationship Between Minimum Wage Increases, Average Hourly Wage Increases, and Underpayment Among Individuals Ages 16-21 or Ages 16-65 by Race, Ethnicity, and Nativity Using Continuous Minimum Wage Variation Controlling for Industry

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Sample	Full Sample		Non-Hispanic African American		Hispanic		Foreign and Other		Non-Hispanic White	
Dependent Variable	Hourly Wage	Underpayment	Hourly Wage	Underpayment	Hourly Wage	Underpayment	Hourly Wage	Underpayment	Hourly Wage	Underpayment
					Panel A: Ages 16-21 No Macro Controls					
Effective Minimum Wage	0.435***	0.050***	0.350***	0.079***	0.430***	0.054***	0.511***	0.045***	0.414***	0.051***
	(0.027)	(0.004)	(0.108)	(0.029)	(0.024)	(0.008)	(0.045)	(0.008)	(0.026)	(0.006)
					Panel B: Ages 16-21 With Macro Controls					
Effective Minimum Wage	0.396***	0.052***	0.267**	0.095***	0.404***	0.058***	0.456***	0.038***	0.395***	0.051***
	(0.035)	(0.005)	(0.100)	(0.022)	(0.051)	(0.013)	(0.056)	(0.011)	(0.034)	(0.007)
Observations	52,065	52,065	3,765	3,765	7,583	7,583	6,700	6,700	34,017	34,017
					Panel C: Ages 16-65 No Macro Controls					
Effective Minimum Wage	0.119***	0.018***	0.105***	0.013	0.124***	0.027***	0.122***	0.021***	0.070***	0.014***
	(0.017)	(0.003)	(0.034)	(0.009)	(0.019)	(0.004)	(0.022)	(0.003)	(0.024)	(0.002)
					Panel D: Ages 16-65 With Macro Controls					
Effective Minimum Wage	0.110***	0.017***	0.112**	0.014	0.181***	0.024***	0.096***	0.018***	0.089***	0.015***
	(0.023)	(0.003)	(0.045)	(0.010)	(0.031)	(0.005)	(0.033)	(0.004)	(0.023)	(0.003)
Observations	409,121	409,121	34,320	34,320	34,186	34,186	83,879	83,879	256,736	256,736

Notes: This table reports regression results examining the effect of minimum wage increases on average hourly wages and underpayment for different samples of workers. The dependent variable is an individual's reported hourly wage in Columns 1, 3, 5, and 7, and the amount of reported underpayment for individuals with reported hourly wages below the effective minimum wage in Columns 2, 4, 6, and 8. The sample is from the CPS MORG and consists of individuals ages 16-21 (Panels A and B) or 16-65 (Panels C and D) who are employed; paid by the hour; do not receive tips, commissions, or overtime; and do not have imputed wage rates. Columns 1 and 2 display estimates of the effect of minimum wage changes on average hourly wages and underpayment among all individuals ages 16-21 or 16-65, Columns 3 and 4 display estimates of the effect of minimum wage changes on average hourly wages and underpayment among native-born non-Hispanic African Americans, Columns 5 and 6 display estimates of the effect of minimum wage changes on average hourly wages and underpayment among Hispanics, Columns 7 and 8 display estimates of the effect of minimum wage changes on average hourly wages and underpayment among foreign-born and other individuals, and Columns 9 and 10 display estimates of the effect of minimum wage changes on average hourly wages and underpayment among native-born, non-Hispanic whites. All specifications include month, year, month-year, and state fixed effects, as well as dummy variables for each education group, age, and each industry code *dind02*, which is an NBER created 2-digit NAICS-based Detailed Industry Classification Code that is consistent over all the years in our sample. The specifications with "macro controls" reported in Panels B and D also include controls for state house prices, income per capita, and prime-age employment. Standard errors are clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1

Table A4. Relationship Between Minimum Wage Increases, Average Hourly Wage Increases, and Underpayment Among Individuals Ages 16-21 and 16-65 by Race, Ethnicity, and Nativity Using Continuous Minimum Wage Variation and Fully Saturated Regression Specification Controlling for Industry

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sample	Ages 16-21		Ages 16-21		Ages 16-65		Ages 16-65	
Dependent Variable	Hourly Wage	Underpayment	Hourly Wage	Underpayment	Hourly Wage	Underpayment	Hourly Wage	Underpayment
Panel A: Regression Results Sample X Wage Interaction								
Effective Minimum Wage	0.414***	0.051***	0.395***	0.051***	0.070***	0.014***	0.089***	0.015***
	(0.026)	(0.006)	(0.034)	(0.007)	(0.024)	(0.002)	(0.023)	(0.003)
Effective Minimum Wage X African American	-0.064	0.028	-0.128	0.045**	0.035	-0.001	0.023	-0.000
	(0.096)	(0.029)	(0.090)	(0.021)	(0.031)	(0.008)	(0.037)	(0.008)
Effective Minimum Wage X Hispanic	0.016	0.003	0.009	0.007	0.054***	0.013***	0.093**	0.010*
	(0.033)	(0.011)	(0.051)	(0.015)	(0.020)	(0.004)	(0.038)	(0.006)
Effective Minimum Wage X Foreign-Born	0.097**	-0.006	0.061	-0.013	0.052*	0.007**	0.007	0.004
	(0.044)	(0.009)	(0.048)	(0.012)	(0.027)	(0.003)	(0.025)	(0.003)
Ln(Income per Capita)			0.092	-0.024			-0.228	0.003
			(0.770)	(0.244)			(0.494)	(0.065)
House Price Index / 1000			0.696	0.014			-0.568	-0.021
			(0.685)	(0.195)			(0.558)	(0.061)
State prime-age emp-to-pop ratio			-0.095	0.023			0.251	-0.019
			(0.386)	(0.084)			(0.168)	(0.028)
Panel B: Differences of Coefficients in Panel A								
African American - Hispanic	-0.080	0.025	-0.137	0.037	-0.019	-0.014	-0.070	-0.010
	(0.104)	(0.032)	(0.100)	(0.026)	(0.040)	(0.010)	(0.057)	(0.010)
African American - Foreign	-0.161*	0.034	-0.189**	0.057**	-0.017	-0.009	0.016	-0.004
	(0.083)	(0.031)	(0.082)	(0.024)	(0.030)	(0.009)	(0.040)	(0.009)
African American - White	-0.064	0.028	-0.128	0.045**	0.035	-0.001	0.023	-0.000
	(0.096)	(0.029)	(0.090)	(0.021)	(0.031)	(0.008)	(0.037)	(0.008)
Hispanic - Foreign	-0.081*	0.009	-0.052	0.020	0.002	0.005	0.086*	0.006
	(0.044)	(0.012)	(0.052)	(0.019)	(0.028)	(0.004)	(0.046)	(0.006)
Hispanic - White	0.016	0.003	0.009	0.007	0.054***	0.013***	0.093**	0.010*
	(0.033)	(0.011)	(0.051)	(0.015)	(0.020)	(0.004)	(0.038)	(0.006)
Foreign - White	0.097**	-0.006	0.061	-0.013	0.052*	0.007**	0.007	0.004
	(0.044)	(0.009)	(0.048)	(0.012)	(0.027)	(0.003)	(0.025)	(0.003)
Observations	52,065	52,065	52,065	52,065	409,121	409,121	409,121	409,121

Notes: This table reports regression results from the fully saturated model examining the effect of minimum wage increases on average hourly wages and underpayment for different samples of workers. The dependent variable is an individual's reported hourly wage in Columns 1, 3, 5, and 7, and the amount of reported underpayment for individuals with reported hourly wages below the effective minimum wage in Columns 2, 4, 6, and 8. The sample is from the CPS MORG and consists of individuals who are employed; paid by the hour; do not receive tips, commissions, or overtime; and do not have imputed wage rates. Columns 1-4 display estimates of the effect of minimum wage changes on average hourly wages and underpayment among all individuals ages 16-21, and Columns 5-8 display estimates of the effect of minimum wage changes on average hourly wages and underpayment among individuals 16-65. All specifications include month, year, month-year, and state fixed effects, as well as dummy variables for each education group, age, and each industry code *dind02*, which is an NBER created 2-digit NAICS-based Detailed Industry Classification Code that is consistent over all the years in our sample. Standard errors are clustered at the state level. *** $p<0.01$, ** $p<0.05$, * $p<0.1$