Understanding "Wage Theft":

Evasion and Avoidance Responses to Minimum Wage Increases

by

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Abstract

This paper presents strong evidence that minimum wage increases lead to a greater prevalence of subminimum wage payment. Using the Current Population Survey, we estimate that increases in measured underpayment following minimum wage increases average between 12 and 17 percent of realized wage gains. In addition, we find that firms and workers comply to a far greater degree with minimum wage increases that are forecastable, modest, and regular than with minimum wage increases enacted through new legislation. We also find evidence that states' enforcement regimes influence the compliance patterns we observe. We interpret these findings as evidence that while minimum wage compliance is the norm, noncompliance is an important, economically nuanced reality in the low-wage labor market.

Keywords: minimum wage, subminimum wage, compliance, noncompliance, enforcement
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Section I: Introduction

Compliance is a crucial and understudied dimension of the minimum wage's labor market effects.[1] In this paper, we investigate a set of key issues regarding the pervasiveness and determinants of subminimum wage payment (sometimes termed "wage theft" in the U.S. context). First, we estimate the extent of "subminimum wage payment on the margin." That is, we quantify the change in subminimum wage payment following recent minimum wage increases. Second, we investigate whether a minimum wage increase's magnitude and forecastability shape the extent of subsequent subminimum wage payment. Third, we investigate the relationship between subminimum wage payment and enforcement regimes.

Our empirical analysis focuses on recent minimum wage changes, enacted from January 1, 2011, to December 31, 2019. This decade offers an attractive empirical environment for two reasons. First, the 2008 financial crisis was followed by a period of stability in both state and federal minimum wage policy. Second, subsequent changes in states' minimum rates exhibited historically dramatic variations. This policy environment — a "pre period" prior to policy changes across states, followed by substantial state-level policy changes of varying magnitudes — offers an opportunity to conduct transparent analyses using both traditional and recently developed empirical methods.

We begin by investigating whether subminimum wage payment becomes more common when the minimum wage rises. We find strong evidence that it does. In our baseline analysis of

[1] Economic models of compliance extend at least as far back as Becker's (1968) analysis of the economics of crime. A familiar application to financial misdeeds involves tax evasion, as in the model of Allingham and Sandmo (1972). The model suggests that the decision to evade will be a function primarily of the gains from successful evasion, the probability of detection, and the penalties associated with being caught. A similar dynamic may be at work with firms' decisions to pay subminimum wages. Analyses by Ashenfelter and Smith (1979), Grenier (1982), Chang and Ehrlich (1985), and Yaniv (1994) have brought related insights to the minimum wage literature.

young workers ages 16 to 25, we find that a one-dollar increase in the minimum wage predicts, on average, a wage gain of 29 cents and a 3.6 cent increase in underpayment. A consistent finding across our analysis samples is that increases in measured underpayment average in the neighborhood of 10 to 20 percent of realized wage gains. On average across the country, we estimate that each dollar of minimum wage increase would, if applied nationally, have generated an increase in subminimum wage payment of roughly $1.16 billion and an increase in realized wage gains, among the employed, of roughly $6.86 billion. Our results thus suggest that compliance with the minimum wage is the norm, but that avoidance and evasion are nontrivial.

Next, we find far larger increases in subminimum payment following increases that were enacted through new legislation than following increases that came about due to pre-existing laws that call for annual, inflation-indexed updates to states' minimum wages. Relatedly, we find that observed wage rates regularly move in lockstep with the minimum wage itself under the inflation-indexing regimes. The regularity and forecastability of inflation-indexed minimum wage increases thus appear to have a substantial impact on compliance.[2] Finally, we find that enforcement regimes mediated the extent to which minimum wage increases led to increases in subminimum wage payment. Below, we elaborate on how these findings relate to the literature's understanding of the causes and consequences of compliance with minimum wages.

Because self-reported wage data may be reported with error, it is challenging to analyze subminimum wage payment in the U.S. labor market. Our analysis thus considers and accounts

[2] With respect to the economic determinants of subminimum wage payment, we interpret this finding as providing evidence that the amount of time firms have had to adjust in response to a minimum wage increase is a key factor. A full assessment of the welfare implications of inflation-indexed minimum wage increases would depend on a number of additional factors, including the employment effects these regimes have when they are first implemented, as analyzed by Brummund and Strain (2020).

for issues including exemptions for tipped workers, occupational exemptions, substate minimum wage rates, and survey item non-response. We assess measurement error's potential role in explaining both our overall estimates and key findings from our heterogeneity analyses.

We emphasize that we are investigating compliance with minimum wages *on the margin*. That is, we estimate the increase in subminimum wage payment that occurs following changes in the minimum wage. We are not attempting to estimate the total amount of noncompliance at any given point in time, which would require making much stronger assumptions. For the task at hand, the key assumption we must make is that changes in the role of measurement error in self-reported subminimum wage payment are not correlated with minimum wage changes. While nontrivial, this assumption is weaker than the assumptions required to estimate the overall prevalence of subminimum wage payment, perhaps using a structural model that attempts to account and correct for measurement error. Of course, a structural approach can only correct for measurement error subject to strong assumptions about the properties of the error. We thus prefer to take the more modest approach of acknowledging measurement error's potential relevance and investigating its plausibility as an explanation for our findings along several dimensions.

Our analysis requires assuming that measurement error has not generated a spurious, systematic correlation between *changes* in the minimum wage and *changes* in the amount of subminimum wage payment we observe. We conduct several lines of analysis to investigate the plausibility of this assumption. First, we show that minimum wage increases do not predict changes in the relevance of selection margins linked to imputation and measurement error. We then discuss evidence that a canonical measurement error model is unable to match key patterns we observe in the prevalence of subminimum wage payment. Finally, we find that economic

features of states' labor market institutions predict substantial variations in the prevalence of subminimum wage payment. Measurement error does not predict systematic variations of this sort. Our evidence on the role of enforcement and wage-setting institutions thus pushes against the hypothesis that the variations in subminimum wage payment we observe are driven, either entirely or even to a substantial degree, by measurement error.

Our analysis contributes to an existing set of studies on the empirical predictors of noncompliance with minimum wages. In the U.S. context, analyses have found that violation rates are correlated with several of the factors that arise in classic models.[3] Both Weil (2005) and Bernhardt, Spiller, and Theodore (2013), for example, find high violation rates in industries in which firms have a limited ability to pass labor costs on to consumers. Bernhardt, Spiller, and Theodore (2013) also find that firms' management structures shape compliance behavior.

Compliance rates vary substantially around the world. 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. Garnero (2018) finds evidence of substantial noncompliance in Italy's labor markets, in particular among small firms and in the wages paid to women and temporary workers. Garnero and Lucifora (2021) find evidence of

[3] Empirical findings in this literature are typically connected to insights from an earlier theoretical literature (Ashenfelter and Smith, 1979; Grenier, 1982; Chang and Ehrlich, 1985) that applies the theoretical lens of Becker's (1968) economic analysis of crime to the issue of minimum wage compliance. This literature finds that evasion and avoidance behavior will tend to be increasing in such factors as the degree to which the minimum wage exceeds the market wage, the magnitude of the elasticity of demand for a firm's output, the resources devoted to identifying violations, and the severity of the penalties associated with violation. Subsequent theoretical work has brought insights related to partial compliance (Yaniv, 2001) and optimal enforcement strategies.

noncompliance as a margin that can mitigate the extent of employment declines in response to minimum wage increases. Caliendo, Schröder, and Wittbrodt (2019) discuss evidence from several recent papers on compliance in the context of Germany's recent introduction of a statutory minimum wage. The evidence suggests moderately high rates of noncompliance in the short run (Caliendo *et al.*, 2018; Bruttel, Baumann, and Dütsch, 2018).

In the United Kingdom, the Low Pay Commission has paid significant attention to the issue of noncompliance with minimum wages and has published annual reports on this issue since 2017. Using data from the UK Labour Force Survey of workers and the Annual Survey of Hours and Earnings, the Low Pay Commission (2020) reported substantial and relatively consistent rates of subminimum wage payment over time. A key question raised by the report is the extent to which subminimum wage payment reflects regulatory avoidance and evasion, and thus in need of remedy primarily through greater enforcement, versus reflecting deficits in employer and employee regulatory awareness, and thus in need of remedy primarily through additional information provision.

A final set of papers has highlighted a conceptually relevant connection between minimum wages and tax compliance. This research emphasizes the fact that the minimum wage imposes a floor on firms' wage reporting, since earnings that would fall below the minimum wage are suspicious, and can increase firms' audit probabilities. Gavoille and Zasova (2021), for example, find that likely-tax-evading firms in Latvia are less likely to reduce employment following a minimum wage hike. Such firms are able to "comply" with the minimum wage increase by reporting wages that had previously been paid but not reported to the tax authority. An implication of this finding is that the apparent beneficiaries of a minimum wage increase can,

under these circumstances, experience a reduction in their net-of-tax income following the increase in the minimum wage. Tonin's (2011) analysis of the effect of a large 2001 increase in Hungary's minimum wage is consistent with this concern, as he finds evidence that consumption decreases among workers whose reported earnings rose with the increase in the minimum wage.[4] In a cross-country analysis, Tonin (2013) finds a strong positive correlation between the fraction of a country's workers earning the minimum wage and the degree of underreporting of earnings. Put differently, more workers' reported wages are bunched at the minimum wage in countries with relatively large underground economies.

We contribute to this literature in two ways. First, we provide new evidence on the magnitude of noncompliance following minimum wage increases in the recent U.S. context, which is empirically attractive due to substantial variations in states' minimum wage regimes. Second, we develop two sets of facts, one involving enforcement institutions and one involving wage setting institutions, that shed light on the economics of subminimum wage payment.

With respect to enforcement institutions, we find that increases in the prevalence of sub-minimum wage payment were largest in states with relatively *strong* enforcement regimes. This finding is consistent with models that incorporate the worker's incentive to report subminimum wage payment, as in Yaniv (1994) and Badaoui and Walsh (2022). In such models, strong enforcement regimes encourage reporting and compliance when the minimum wage is low, such that enforcement is in the worker's interest. If the minimum wage rises beyond the level an

[4] Biro, Prinz and Sandor (2021) study a different policy experiment in the Hungarian context. They analyze a shift in the tax authority's focal point in which the tax authority increases audit probabilities for firms that declare workers' earnings below double the minimum wage. They find a large fraction of private sector employees who previously reported earning the minimum wage immediately declare earnings at double the minimum wage. This policy change was associated with exits from formal employment.

employer would be willing or able to pay, however, enforcement may cease to be in the worker's interest. As the minimum wage crosses this threshold, reductions in compliance will tend to be larger under strong enforcement regimes because these were precisely the regimes in which workers had an incentive to report noncompliance at baseline.

With respect to wage setting institutions, we find that compliance is far stronger when minimum wage increases are regular and forecastable than when they are newly legislated. Noncompliance is one of many margins along which firms might respond to minimum wage increases (Clemens, 2021). As highlighted by Basu, Chau, and Kanbur (2010) as well as by Garnero and Lucifora (2021), this can imply tradeoffs between enforcement and the minimum wage's effects on employment.[5] Notably, adjustments to personnel, benefits, and the structure of the workplace take time to implement, while noncompliance arises automatically if firms fail to raise wages. Noncompliance may thus be more prevalent as firms respond to newly legislated minimum wage increases than when increases are baked into longstanding legislation. Our additional evidence on dynamics shows that compliance improves by the end of our sample following moderate minimum wage increases, but not following large increases. When it is more costly for firms to comply, the required adjustments take longer to unfold.

Our paper proceeds as follows. Section II describes recent changes in states' minimum wage policy regimes. Section III describes the data we analyze. Section IV presents our empirical methodology. Sections V presents our empirical analysis and Section VI concludes.

[5] The findings of Gavoille and Zasova (2021) are also related thematically. Specifically, Gavoille and Zasova (2021) find that the employment effects of minimum wage increases are more pronounced for tax compliant firms than for tax evading firms. They interpret this finding as reflecting the fact that tax evading firms may be paying high wages to begin with, such that "complying" with the minimum wage increase requires converting unreported wages into reported wages rather than paying higher wages.

Section II: Background on Recent State Minimum Wage Changes

As we have noted in previous work (Clemens and Strain 2017, 2018, 2021), there was a pause in both state and federal efforts to increase minimum wages during the years following the Great Recession. After that pause, states' minimum wage policies diverged considerably. Many states kept their minimum wage rates at the $7.25 federal minimum, while others enacted increases ranging from less than $1 to in excess of $4. This combination of a "pre period" with stable minimum wages and a "post period" with substantial policy variations provides an attractive empirical environment. In Section IV, where we present our empirical methodology, we further discuss the potential challenges we face in using this variation to estimate the causal effect of minimum wage increases on rates of subminimum wage payment.

The decade we analyze is of interest in part because variations in states' minimum wage increases were historically large. Through January 2019, the average increase enacted by states with minimum wage increases exceeded 25 log points, with a number of states enacting substantially larger increases. In contrast, for example, the 138 state-level increases studied by Cengiz *et al.* (2019) average just over eight log points.

We take two approaches to analyzing recent minimum wage variation. First, we make straightforward use of the level of each state's minimum wage on a monthly frequency. Second, we divide states into four qualitatively distinct policy regimes. The first captures whether a state's minimum wage increases were regular and forecastable because they arose due to inflation-indexing provisions rather than new legislation. Among states with increases that were driven by new legislation, we differentiate between "large" and "small" increases. This allows us to investigate whether the response of subminimum wage payment is nonlinear. Table 1 lists

states according to the primary policy categories we employ, which follows the categorization we developed in earlier work (Clemens and Strain, 2017; 2018).[6] Figure 1 plots the time paths of each policy grouping's average effective minimum wage. We view the continuous and categorical approaches to describing variation in minimum wage policy as complementary.

When the minimum wage is indexed to inflation, minimum wage increases are regular, in that they occur annually, and forecastable, in that firms know to expect them (Brummund and Strain, 2020). When an inflation-indexing provision has been in place for many years, forward-looking firms have had time to adjust their personnel and benefits packages to account for forecastable changes in labor costs. The compliance margin may thus be less relevant as firms respond to these forecastable minimum wage changes than when they begin to adjust in response to wage increases required by new legislation.

As shown in Figure 1, the total minimum wage increases enacted by "indexers" and the "small" statutory increases are quite similar through the end of our sample. Comparisons between these groups can thus provide insight into the relevance of forecastability *per se*. That is, these comparisons can reveal whether firms' and workers' ability to anticipate and plan for a minimum wage increase reduces the extent of subminimum wage payment in its wake.

A second dimension along which we examine states' policy regimes involves enforcement. That is, the pervasiveness of subminimum wage payment may be shaped by the stringency of a state's minimum wage enforcement regime. This analysis makes use of a pair of enforcement indices developed by Galvin (2016), on which we provide additional detail below.

[6] This initial categorization of states is based on the minimum wage changes states enacted between January 2013 and January 2015. We also present analysis using an updated categorization that is based on changes enacted between January 2013 and January 2017.

Section III: Data Sources

In this section we discuss the data sources and variables we use, including wage data, subminimum wage variables, measures of enforcement regimes, 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).

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.

Our analysis tracks the relevance of several margins along which data limitations could inhibit our identification of wage subminimum wage payment. The first is whether the individual is an hourly worker. The second is whether the individual has actually responded to the questions required to estimate their wage rates without imputation. The third is whether the individual receives tips or commissions, as tipped workers are typically exempt from states' general minimum wage. The fourth is whether the individual is in an occupation that may, for other reasons, be exempt from the Fair Labor Standards Act. The fifth is whether the individual lives in a state in which substate governments have enacted their own minimum 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.

Some workers may be exempt from the minimum wage due to their occupation (under a duties test) or their earnings. We obtain data on these exemptions from the Wage and Hour Division of the Department of Labor. We also account for the fact that substate minimum wage rates have become increasingly common. Our basic approach is to investigate whether our full-sample estimates are substantively altered by excluding observations that are potentially affected by these occupational exemptions or substate minimum wage rates.

Subminimum wages and underpayment

For our analysis of subminimum wage payment, we follow work set in countries outside of the United States (Goraus-Tańska and Lewandowski, 2019; Bhorat, Kanbur, and Mayet, 2013)[7] in describing subminimum wage payment using both a binary indicator and a continuous measure of subminimum wage payment's depth. The first variable is a simple indicator for subminimum wage payment. To avoid overstating the pervasiveness of subminimum wage payment due to modest reporting error, our primary measure is an indicator for whether the individual's self-reported wage is more than 25 cents less than the minimum wage effective in his or her state of residence during the relevant month. The second variable is a continuous measure of the extent to which wage rates fall short of the legislated minimum. The first measure, which we term "subminimum wage payment," can be described as a measure of the extensive margin of noncompliance, while the second measure, which we term "underpayment," incorporates both the intensive and extensive margins. Both measures are set equal to 0 for individuals who report wage rates higher than the minimum wage.

Enforcement measures

To analyze the relevance of states' minimum wage enforcement regimes, we make use of data presented and analyzed by Galvin (2016). Galvin documents a broad set of enforcement regime characteristics, which he summarizes with two indices. The first focuses on aspects of

[7] In a related recent study of compliance in India, Mansoor and O'Neill (2020) use an index known as the Foster–Greer–Thorbecke poverty metric.

states' regimes that relate to the penalties faced by violators who are caught.[8] The second incorporates information on the authority of enforcement agencies, the operation of enforcement mechanisms, and the size of the penalties associated with minimum wage violations.[9] These indices are calculated based on states' regimes as of December 31, 2013, which falls just before the wave of minimum wage legislation around which we have built our analysis.

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 statewide median house price index from the Federal Housing Finance Agency (FHFA). We proxy for aggregate economic performance using data on 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 skill groups that are not directly affected by the

[8] Galvin's penalty index includes information on the maximum value of damages, civil penalties, and administrative fees public agencies or private arbitration can order an employer to pay, as well as whether an offender can face civil and criminal charges because of a wage violation. The index also details the burden of proof: whether employers must prove their actions were not in retaliation for complaints regarding wages or working conditions, whether the state agency or private arbiter has discretion, or whether the employer must be found a willful or repeat offender.
[9] Galvin's broader enforcement index includes the measures in the penalties index and details regarding how state enforcement agencies operate. These include whether state administrative agencies have subpoena power, whether agencies must exhaust administrative processes before bringing a civil suit, whether they can issue wage orders or binding interpretations of regulations, whether they have power to issue final determinations, and whether states can seek remedies in civil court on behalf of an employee. The index also incorporates information on the duration of statutes of limitations, and the payment of attorney's fees.

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

Summary statistics and sample selection

Table 2 presents summary statistics on several relevant samples. Columns 1, 3, 5, and 7 present data from 2011 to 2013 — namely, the baseline period during which few minimum wage changes took place — while Columns 2, 4, 6, and 8 present data from 2016 to 2019. Data on house prices, employment, and aggregate income growth are indicative of the economic recovery that took place over both periods. Columns 1 and 2 present data on the full population ages 16 to 25; Columns 3 and 4 describe the employed; Columns 5 and 6 restrict attention to hourly workers who are not tipped and who responded to questions related to their wage rates so that their wage rates are not imputed; Columns 7 and 8 drop individuals who live in states with city-specific minimum wage rates, or specific minimum wage rates for small businesses or businesses providing health insurance, along with workers who might be exempt from the minimum wage due to their occupation.[10]

While our baseline analysis sample consists of individuals ages 16 to 25, we present estimates for both broader samples and more narrowly selected samples. We present estimates

[10] The states dropped are Arizona, California, Illinois, Iowa, Kentucky, Maine, Maryland, Minnesota, Nevada, New Mexico, New York, Oregon, and Washington. Department of Labor regulations exempt employees in certain "white collar" occupations from minimum wage requirements. To be considered exempt, employees must meet minimum requirements related to their primary job duties and, in most instances, must be salaried and must earn more than a minimum amount. DOL has assigned probabilities to occupations for whether employees in that occupation would pass the duties test and be exempted from minimum wage requirements, provided the employees also pass the salary and earnings requirements. We drop workers in any occupation who have a nonzero probability of being exempt, provided that the workers also were not paid by the hour and earned at least $455 per week. Our analysis is consistent with federal regulations as of 2016 that were amended in 2019.

for a sample of individuals ages 16 to 21, for example, since this more narrowly selected group is the focus of many studies of the minimum wage's effects on employment. Our goal in the present paper is to estimate the overall labor market prevalence of subminimum wage payment in response to minimum wage changes. We thus focus primarily on broader samples than do analyses that estimate the minimum wage's effects on employment.

Section IV: Estimation Frameworks

This section walks through the empirical models we estimate. The initial analysis we present can be described as difference-in-differences estimates that use the policy groupings described in Section II. We also consider an alternative grouping, for which the division of states appears in Appendix Table A1. The basic specification is presented in equation (1) below:

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

For our primary analyses, $S_{i,s,g(s),t}$ is a binary indicator of whether individual *i*, living in state *s*, in policy grouping *g(s)*, in time period *t* is working at a subminimum wage, which we define to be a wage that is more than 25 cents below his or her state's effective minimum wage rate.

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 more skilled than those in the analysis sample, and individual-level demographic characteristics.

We use $Policy_{g(s)}$ to represent binary indicators for whether a state fits into a given policy group. As discussed above, we differentiate among states that increased their minimum wage rates due to inflation-indexing provisions, states that enacted large statutory increases, and states that enacted small statutory increases. The coefficients of interest, $\beta_{g(s)}$, describe whether the incidence of subminimum wage payment rose more, less, or roughly the same in the active policy regimes relative to states in which no minimum wage increases occurred. Comparisons of the point estimates associated with different policy groups (e.g., the inflation-indexing group vs. the group that enacted large new statutory increases) provide evidence on whether states that enacted alternative forms of minimum wage increases had different experiences. We note that a standard interpretation of these comparisons across treatment regimes requires a stronger assumption than the more basic parallel trends assumption required for binary treatment settings (Callaway, Goodman-Bacon, and Sant'Anna, 2021).[11] To capture the "medium-run" relationship between minimum wage increases and the incidence of subminimum wage payment, we exclude data from 2014 and 2015 from the samples on which we estimate equation (1). We thus estimate differential changes from a baseline period consisting of 2011–2013 to an end line consisting of 2016–2019.

Several classes of factors could lead the $\beta_{g(s)}$ to be biased estimates of the causal effects of minimum wage increases on rates of subminimum wage payment. First, we consider the question of whether measurement error is generating a mechanical correlation between minimum wage increases and measured rates of subminimum wage payment. Second, we consider biases

[11] As discussed by Callaway, Goodman-Bacon, and Sant'Anna (2021), a causal interpretation of comparisons of "high dose" and "low dose" treatments requires assuming that the units that received the high dose treatment would have evolved on the same post-treatment path as the low dose units had they received the low dose rather than the high dose they received in practice.

that could arise if minimum wage increases were correlated with economic shocks that exert independent influence on compliance patterns. Third, we consider the possibility that minimum wage increases were enacted endogenously in response to factors that exert independent influence on compliance patterns. The latter two analyses take two forms. The first is to investigate the robustness of our estimates to adopting a rich set of strategies for controlling for biases from both observable and unobservable factors. The second is to implement a set of event study estimators to check whether outcomes of interest began to diverge during the time periods prior to our treatment states' implementation of minimum wage increases.

In difference-in-differences empirical settings, it has been standard practice to implement what we refer to as a "traditional event study" estimator. The traditional event study estimator, as written in equation (2), provides a check for the relevance of "divergent pre-existing trends," which can be an indication of potential sources of bias:

$$S_{i,s,g(s),t} = \sum_{g(s),p(s,t)\neq 0} \beta_{g(s),p(s,t)} Policy_{g(s)} \times Event\ Year_{p(s,t)} + \alpha_{1s} State_s + \alpha_{2t} Time_t$$

$$+ X_{i,s,t}\gamma + \varepsilon_{i,s,t}, \qquad (2)$$

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. In equation (2), we interact a set of "event time" dummy variables with indicators for a state's policy grouping. The event time dummy variables are coded to correspond with specific numbers of years relative to the enactment of a state's first minimum wage increase during the sample. 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 coefficients of interest can thus be interpreted as differential

changes in subminimum wage payment 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 subminimum wage payment had occurred prior to the minimum wage increase's enactment. Estimates for years following the minimum wage increase track the dynamics with which subminimum wage payment subsequently evolved.

Recently, a growing set of papers have shown that the traditional event study estimator can fail to produce estimates that map into treatment effects of interest 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). As robustness analyses, we thus present results from both a traditional event study estimator and two of the more recently proposed estimators. In addition to the traditional event-study estimator, we present estimates from a "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), 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.

Next, we implement equation (3), as described below:

$$S_{i,s,t} = \beta_1 MW_{s,t} + \alpha_{1s}\, State_s + \alpha_{2t}\, Time_t + X_{i,s,t}\,\gamma + \varepsilon_{i,s,t}. \qquad (3)$$

The key difference between β_1 and $\beta_{g(s)}$ from equation (1) is that the minimum wage variable $MW_{s,t}$ is continuous. We estimate equation (3) using data for all years from 2011 to 2019. The

effects captured by equation (3) can be described as "contemporaneous" and "per dollar of minimum wage increase." We also use equation (3) to analyze effects on hourly wages.

Finally, we assess whether subminimum wage payment on the margin has varied with the stringency of states' minimum wage enforcement regimes. Specifically, we estimate:

$$S_{i,s,t} = \beta_1 MW_{s,t} + \beta_2 Enforcement\ Index_s \times MW_{s,t} + \alpha_{1s}\, State_s + \alpha_{2t}\, Time_t + X_{i,s,t}\,\gamma + \varepsilon_{i,s,t}. \quad (4)$$

In estimates of equation (4), β_2 provides evidence on whether the relationship between minimum wage increases and subminimum wage payment varies across enforcement regimes.

Section V: Analysis of Subminimum Wage Payment on the Margin

In this section we present results from the analyses described above. After presenting simple time series tabulations, we present regression estimates of equations (1), (2), (3), and (4).

Initial evidence on the evolution of subminimum wage payment across minimum wage regimes

Figure 2 provides a graphical look at the data underlying our analysis. The figure reports time series separately for the groups we categorize as "no changers," "small changers," "large changers," and "indexers" in Table 1. Appendix Table A2 supplements the time series in Figure 2 with tabulations and calculations of changes from a baseline period including 2011–2013 to an end line period including 2016–2019.

Figure 2 presents data on the fraction of individuals who report working for wage rates more than 25 cents less than their respective states' effective minimum wage rates. Panels A through D present data on several subsamples of the CPS MORG files. The "full sample" in Panel A consists of all employed individuals ages 16 to 25. The sample in Panel B is restricted to 16-to-25-year-olds who were employed and who reported working on an un-tipped hourly wage basis (rather than on salary). The sample in Panel C is restricted to workers who, in addition to being paid hourly, responded to the survey's wage questions such that no imputations were required. Finally, the sample in Panel D is restricted to workers who additionally did not live in a state with substate minimum wage rates and did not work in an occupation exempt from the federal minimum wage according to the Fair Labor Standards Act.

Two patterns emerge across the panels of Figure 2. First, the incidence of subminimum wage payment rose substantially in states that enacted minimum wage increases through new legislation. The consistency of this result across samples is important because it ensures that this finding is not driven by a tendency for the BLS's imputation procedures to erroneously assign wage rates that are above the federal minimum wage but below the minimum wage applicable in the state in which an individual is employed. Our restrictions also ensure that the changes we observe are not driven by shifts across the margin between hourly wage arrangements and salaried work or by shifts into or out of tipped arrangements.

Second, we find that states that index their minimum wage rates for inflation have experienced no increase in the incidence of subminimum wage payment. Indeed, the prevalence of subminimum wage payment may have modestly decreased in these states, even as their minimum wage rates have risen. Below, we more fully explore this difference between inflation-

indexed minimum wage increases and newly legislated minimum wage increases. Appendix Figure A1 shows that the patterns we observe in Figure 2 are little changed by shifting to the categorization of states presented in Appendix Table A1. Figures A2 and A3 show the patterns observed for individuals ages 16–25 are similar for a broader sample of individuals ages 16–65, though the overall incidence of subminimum wage payment is smaller.

Regression estimates of the pervasiveness of subminimum wage payment on the margin

This section presents regression estimates of the extent to which the incidence of subminimum wage payment expands as the minimum wage rises. Our regression models allow us to place confidence bands on our estimates and provide a framework for investigating their robustness. In particular, we assess their robustness to accounting for states' macroeconomic conditions, for variations in the demographic characteristics of the individuals in each sample, and for margins that may contribute to measurement error.

Table 3 presents estimates of equation (1), which closely tracks the presentation of the data in Figure 1. As in Figure 1, we allow the estimates to differ across the states we categorize in Table 1 as "indexers," "small statutory increasers," and "large statutory increasers." The estimates show that subminimum wage payment rose substantially in states that increased their minimum wage rates through new legislation relative to those that did not increase their minimum wage rates. There was no relative increase in the prevalence of subminimum wage payment in states that increased their minimum wage rates through inflation-indexing provisions.

The distinction between inflation-indexed minimum wage changes and newly legislated minimum wage increases has interesting economic content. Inflation-indexing provisions make

modest minimum wage increases forecastable by both workers and firms. The annual regularity of these states' minimum wage increases may also raise awareness of their occurrence. The wage data reveal that rates of subminimum wage payment change little as minimum wages rise under these conditions. Further, under inflation-indexing regimes we find that wages moved more frequently in lockstep with the minimum wage itself. As shown in Appendix Table B2, each dollar of minimum wage increase in the inflation-indexing states generated a far larger increase in the fraction of workers who report making exactly the minimum wage than did increases enacted through new legislation. As discussed in more detail below, this feature of the data limits the extent to which measurement error can plausibly underlie our results.

The columns of Table 3 show the qualitative robustness of our results across two key margins. First, comparing Columns 1 and 2 reveals that the estimates are little affected by including either a detailed set of demographic control variables or by controlling for proxies for developments in states' labor markets, housing markets, and general macroeconomic conditions. Second, the remaining columns present evidence on the relevance of margins that complicate the measurement of subminimum wage payment. Moving from Columns 1 and 2 to Columns 3 and 4, we restrict the sample to individuals who report being un-tipped hourly wage earners rather than salaried employees. The estimates rise moderately, reflecting that minimum and near-minimum wage payment is more common among hourly wage earners than among salaried workers. In Columns 5 and 6 we remove all individuals with imputed wage values. The point estimates decline, likely because imputation-driven measurement error accounts for a nontrivial fraction of measured subminimum wage payment. This motivates our focus on samples that exclude observations with imputed wage rates. Finally, in Columns 7 and 8, we remove all individuals living in states with substate minimum wage rates, as well as workers who may be

exempt from the federal minimum wage due to their occupation. Relative to Columns 5 and 6, these restrictions have little net effect on the implied relationship between minimum wage increases and the prevalence of subminimum wage payment.

Appendix Table A6 presents estimates for which we extend our sample to include individuals ages 16 to 65 rather than ages 16 to 25. The point estimates are uniformly smaller because older individuals are less likely to work in minimum wage jobs than younger workers. The pattern of coefficients across columns, however, is quite similar.

On the most restricted sample, we estimate a 7.4 percentage point increase (averaged across the specifications in Columns 7 and 8) in the probability that an individual reports earning a subminimum wage in states that enacted large minimum wage increases relative to states that enacted no minimum wage increases. Across all subsamples, the relationship between statutory minimum wage increases and subminimum wage payment is strongly positive, while inflation-indexed minimum wage changes have no detectable effect on subminimum wage payment.

Robustness Analyses

This section presents analyses that explore the robustness of the results presented in Table 3. First, Panel A of Figure 3 presents the "event study" estimates associated with equation (2). As one can largely infer from Figure 2, there is no evidence to indicate worrisome "divergent pre-existing trends." That is, there is no evidence that rates of subminimum wage payment were evolving differently prior to the implementation of states' minimum wage changes. Second, we observe substantial increases in the prevalence of subminimum wage payment in the year following the enactment of states' newly legislated minimum wage increases. Rates of

subminimum wage payment rise further in subsequent years. Notably, these are years during which subsequent minimum wage changes go into effect, as states' minimum wage legislation typically called for a series of minimum wage increases enacted over a number of years. Third, in states that increase their minimum wage rates regularly through inflation-indexing provisions, we see no systematic changes over the full course of our sample.[12]

A recent set of applied econometrics papers has highlighted that estimates of traditional event study models can be biased when treatment effects are heterogeneous and when the policy changes of interest occur at different points in time in different states. Both considerations apply to our empirical setting. The estimates in panel A of Figure 3 may thus be prone to concerns regarding the manner in which treatment events are implicitly weighted (including the possibility of so-called "negative weights"), which have the implication that the estimates may fail to correspond with any underlying treatment effects of genuine interest.

To ensure that these issues are not influencing our results, we thus present additional evidence in panels B and C of Figure 3. We use two estimators that have been introduced as solutions to the weighting issues referenced above. Specifically, we present estimates from a "stacked event study" estimator and the "imputation" estimator. The time profiles of estimates are largely similar across panels A, B, and C of Figure 3. In all cases, there is no evidence of a relationship between inflation-indexed minimum wage increases and subminimum wage payment. And in all cases, there is evidence of substantial subminimum wage payment in response to both small and large increases enacted due to new legislation. In states with

[12] For ease of presentation, the estimates for the "indexer" states are centered on 2014 even though their first within-sample minimum wage increases took effect in 2012. The key inference one can draw from the "indexer" estimates is that subminimum wage payment in inflation-indexing states changed to a similar degree as subminimum wage payment in "no changer" states from the beginning to the end of our analysis sample.

relatively small minimum wage increases, there is some evidence that the prevalence of subminimum wage payment begins to decline in the last year or years of our sample. We view this last finding as suggestive that compliance has begun to adjust to the new environment. In Figure A4, we present similar event studies extending the sample to all individuals ages 16–65. We find similar trends in noncompliance across our policy groups over time.

Appendix Table A3 presents an additional set of robustness analyses. Specifically, it presents estimates of the regression described by equation (3). That is, policy variation in the minimum wage is expressed in dollar terms. In all other respects, the presentation of results in Table A3 mirrors those in Table 3. The pattern of estimates across the columns of Table A3 is broadly similar to the pattern in Table 3.

Appendix Table A4 presents additional estimates that mirror those from Table 3. In this case, the analyses differ with respect to the sample. For Table 3, the samples include individuals ages 16 to 25. In Table A4, we restrict the sample to individuals ages 16 to 21, which is a more conventional sample for minimum wage analyses when the outcome of interest is the individual's employment status. Estimates are modestly larger than those presented in Table 3, but the pattern of estimates across specifications is again broadly similar to the pattern from Table 3.

Appendix Table A7 presents additional evidence on the robustness of the estimates presented in Table 3. The regressions in these tables augment the regressions presented in Table 3 with a set of census region by time period fixed effects. The estimated effects of large minimum wage increases are modestly (roughly 10 percent on average across the 8 columns) smaller, while the estimated effects of small minimum wage increases and inflation-indexed minimum wage increases are essentially unchanged.

Estimating the impact of subminimum wage payment following recent minimum wage increases

In Table 4, we present estimates of equation (3). We estimate both the increase in underpayment payment and the increases in wages received per dollar of minimum wage increase.[13] Columns 1 and 2 present estimates for individuals ages 16 to 25, Columns 3 and 4 expand the sample to include individuals ages 16 to 35, Columns 5 and 6 expand the sample to include ages 16 to 65, while Columns 7 and 8 focus on individuals ages 16 to 21.

When analyzing our baseline samples (hourly workers whose wage rates were not imputed by BLS and who do not receive tips) of individuals ages 16 to 25, we estimate that each dollar of minimum wage increase generates an hourly wage gain of roughly 29 cents. This estimate is relatively insensitive to whether the specification includes our sets of controls for the demographics of individuals in the sample or for changes in each state's macroeconomic conditions. In column 2, we present an estimate showing that each dollar of minimum wage increase predicts, on average, a 3.6 cent increase in underpayment. In these particular specifications, increases in underpayment are about 12 percent of the estimated wage gains. On the sample of individuals ages 16 to 35, as reported in Columns 3 and 4, the corresponding values are 16.3 cents and 2.6 cents, so that underpayment corresponds with roughly 16 percent of estimated wage gains. On the sample of individuals ages 16 to 65, as reported in Columns 5 and 6, the corresponding numbers are 10.3 cents and 1.7 cents, so that underpayment corresponds with just under 17 percent of estimated wage gains. On the sample of individuals ages 16 to 21, as reported in Columns 7 and 8, the corresponding numbers are 38.4 and 5.3 cents, so that

[13] 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.

underpayment corresponds with 14 percent of estimated wage gains. This ratio differs quite modestly from the ratio obtained in columns 1 and 2.[14]

We now extrapolate our estimates to infer the rise in underpayment that would occur in response to a $1 increase in the minimum wage at the national level. Our preferred estimate of this overall effect applies directly to our samples of hourly wage workers who do not receive tips, commissions, or overtime and who do not have imputed wages. Sample weights imply that this sample represented 36.7 million individuals ages 16 to 65 in January 2011.[15] On average across this sample, a dollar of minimum wage increase predicts a 1.7 cent increase in underpayment payment. Over a 35-hour week, increases in underpayment would thus imply a weekly wage loss of roughly 59 cents, on average, for the 36.7 million individuals in question. Multiplied by 52 weeks per year, the total increase in underpayment per dollar of minimum wage increase totals roughly $1.16 billion nationwide (36.7 million workers ages 16-65 x 52 weeks x 35 hours x 1.74 cents in underpayment per hour). If this estimate is extrapolated to all 59.9 million un-tipped hourly wage workers, the total implied increase in underpayment per dollar of minimum wage increase would be about $1.89 billion ($1.16 billion x 59.9/36.7).

Underpayment is concentrated among relatively young hourly wage workers. The sample of hourly workers ages 16 to 25 with non-imputed wages, for example, accounts for roughly 8.8

[14] The sample of individuals ages 16 to 21 more closely corresponds with the typical sample analyzed in studies of the minimum wage's effects on employment. Employment studies focus on relatively young samples in large part because these are the samples that will most plausibly experience any adverse effects of minimum wage increases. At the same time, nontrivial fractions of individuals ages 22 to 25 also earn at or near the minimum wage. In this paper, our analysis seeks to understand how wage gains and underpayment evolve across the labor market as a whole as minimum wages rise. Our primary analysis sample is thus a sample that includes a moderately larger set of potential minimum wage workers. As the present subsection emphasizes, however, our assessment of the degree of underpayment relative to realized wage gains is not particularly sensitive to our choice over the samples on which we estimate these outcomes.

[15] There were an estimated 59.9 million untipped hourly wage workers in total, of whom the observations representing 23.2 million have imputed wage data.

million workers. On this sample, a dollar of minimum wage increase predicts an increase in underpayment of roughly 3.6 cents. This sample accounts for roughly $574 million of the $1.16 billion in underpayment we estimate for the full working-age population. The estimate for the 16 to 35 year old sample is $837 million.

Per dollar of minimum wage increase, the wage gains we estimate for those who are employed are roughly $6.86 billion for the sample ages 16 to 65, $5.24 billion for the sample ages 16 to 35, and $4.71 billion for the sample ages 16 to 25. Our estimated increases in underpayment are thus equivalent to roughly 17 percent of the wage gains for the full working-age population, roughly 16 percent of the wage gains for the population ages 16 to 35, and roughly 12 percent of the increase for the population ages 16 to 25.

In Table A8, we present estimates on the robustness of the results in Table 4 by augmenting the regressions presented with a set of Census region by time period fixed effects (this mirrors the robustness checks presented in Table A7 for Table 3). The estimates are essentially unaffected by the inclusion of these additional covariates. This provides evidence that our main estimates are not influenced by factors that have evolved differentially over time across regions.

Economic Dimensions of Subminimum Wage Payment

We now turn to the question of whether key features of states' minimum wage regimes predict variations in the pervasiveness of subminimum wage payment. We consider two dimensions of states' minimum wage regimes. The first involves the strength of their

enforcement institutions. The second, on which we have already presented results, involves the regularity and forecastability of a state's minimum wage increases.

Table 5 presents estimates of equation (4), which allows the relationship between minimum wages and subminimum wage payment to vary with the strength of a state's minimum wage enforcement regime. We find that increases in the minimum wage predict larger increases in the prevalence of subminimum wage payment under strong enforcement regimes than under weak enforcement regimes. While this finding may initially seem counterintuitive, it arises naturally in models that account for the importance of a worker's decision to report their employer in the enforcement process, as in Yaniv (1994) and Badaoui and Walsh (2022).

When the minimum wage exceeds the wage a firm is able or willing to pay, maintaining a job match may require subminimum wage payment. As a consequence, workers may cease to pursue the minimum wage's enforcement by, for example, choosing not to report a violation of minimum wage regulation. Minimum wage increases can thus lead states with strong enforcement regimes to shift from being states with strong to weak enforcement prevalence. By contrast, states with weak enforcement regimes may have weak enforcement whether the minimum wage is high or low. As Table 5 shows, the differential relationship between minimum wage increases and subminimum wage payment in states with strong enforcement regimes is statistically quite strong. Distributions of underpayment, as presented in Figures A5 and A6, reveal that increases in subminimum wage payment were concentrated at rates between $0.25 and $2.00 below the minimum wage. This plausibly maintains wages that are lower than a firm's willingness to pay and higher than a worker's reservation wage.

As already reported in Table 3, we find no evidence of increases in subminimum wage payment following minimum wage increases that were enacted through inflation-indexing regimes. By contrast, we find evidence that both small and large statutory increases predict increases in subminimum wage payment. Table 3 showed further that subminimum wage payment became substantially more prevalent following larger increases than smaller increases.

The difference we find when comparing states with relatively small minimum wage increases to those with inflation-indexed minimum wage increases provides an initial piece of evidence that compliance under the inflation-indexing regimes may reflect more than simply the smaller magnitude of these states' minimum wage increases. As shown in Figure 1, the average increase in the minimum wage from 2011 to 2019 was quite similar across these groups of states. We provide additional evidence on this issue by restricting our sample to 2016 to 2019, then comparing compliance patterns in states with newly legislated minimum wage increases to those that remained in inflation-indexing regimes. The estimates in Table A9 replicate those from Table 4, but with the sample restricted to 2016 to 2019. The point estimates are very similar when we analyze this more restricted sample. In Table A10 we then drop states that were in inflation-indexing regimes from the sample, so that the estimates are driven exclusively by states with new statutory increases. In Table A11, we drop states with new statutory increases so that the estimates are driven by states that remained in inflation indexing regimes. The estimates in Tables A10 and A11 reveal that even on the sample restricted to the year 2016 to 2019, the subminimum wage payment we estimate emerges primarily in states that implemented minimum wage changes due to recently enacted legislation.

We also note that inflation-indexed minimum wage increases predict a much stronger tracking of wage rates with the minimum wage itself. Specifically, each dollar of minimum wage increase predicts a 2.5 times greater increase in the probability that a worker reports making exactly the minimum wage when the minimum wage increase is driven by an inflation-indexing regime than when it is driven by new legislation. See Table B2 for these results.

Together, these findings suggest that compliance with minimum wage regulation is lowest when it is most costly: compliance is lowest in the face of large minimum wage increases and it is greatest when firms have had ample opportunity to adjust. Firms in states that index their minimum wages to inflation have had a number of years, for example, to adjust their benefits packages and personnel to account for minimum wage increases' effects on their labor costs. Additionally, Figure 2 shows that subminimum wage payment initially increased in states with relatively "small" increases, but then declines over the final years of our sample. Our event study evidence, shown in Figure 3, follows a similar pattern. Compliance in response to small minimum wage increases thus appears to improve with time. In states with "large" increases, in contrast, the rise in subminimum wage payment has plateaued by our sample's end but has not begun to reverse. These findings are consistent with economic models that emphasize the time horizons over which firms might adjust to minimum wage increases along a rich set of margins.

An ideal investigation of subminimum wage payment's persistence would track it for a number of years following the conclusion of a states' minimum wage increases. Unfortunately, there are very few such instances in our sample because most states' recent minimum wage legislation has called for a series of increases phased in over a number of years. We identify nine states that allow us to make some progress on this issue. Specifically, we identify Arkansas,

Delaware, Connecticut, Hawaii, Massachusetts, Nebraska, New Jersey, Rhode Island, and West Virginia as states that had pauses of at least two years following the enactment of an initial set of minimum wage increases. Appendix Figure A7 shows that the minimum wage tended to rise substantially for an average of three years in these states, after which their minimum wage increases taper off. The fourth and subsequent years thus provide an opportunity to investigate whether compliance improves with time. Appendix Figure A8 presents event study analyses of the effects of these states' minimum wage increases on the prevalence of subminimum wage payment.[16] The estimates decline in years 4 and thereafter, suggesting that compliance does indeed improve after a states' minimum wage increases are fully phased in.

Investigation of measurement error

Measurement error is an important issue for our analysis to consider. Figure 2 and Table 3 incorporate our first effort to explore the relevance of measurement error. This first effort involves investigating how our estimates rise and fall as we exclude imputed wage rates and wages inferred for salaried workers from our analysis sample.

A next step in our analysis of measurement error is to explore whether these sample inclusion margins were, themselves, responsive to this period's minimum wage changes. We

[16] Note that even in this restricted set of states, minimum wage increases would resume at the end of our sample or shortly thereafter. For this analysis, we drop any later months and years from the sample if they occur after a resumption of increases in the state's minimum wage.

present this analysis in Appendix Table B1. Reassuringly, we find little evidence of correlations between minimum wage changes and margins relevant to measurement error.[17]

An additional check for the relevance of measurement error is to divide the sample based on whether the respondent to the CPS's questions was the wage earner him or herself or a proxy respondent. It is reasonable to expect proxy respondents to be more likely to report wages with error than will the job-holder him or herself. Proxy respondents may thus be more likely to report subminimum wage payments in error. Comparing these groups is difficult, however, since respondents who report on their own wages are more likely to be older and have higher-wage jobs than the individuals whose wages are reported by a proxy. The latter group, for example, is more likely to include teenage children whose proxy respondent is a parent. The latter group thus ought to be expected to have much greater rates of both minimum and subminimum wage employment. That said, the ratio of underpayment to wage gains might nonetheless be a comparable metric for gauging the relevance of errors from proxy respondents.

In Table A5, we present estimates of wage gains and underpayment separately for self-respondents and proxy respondents. For the workers most directly affected by minimum wage increases, namely those ages 16 to 21, we estimate 14.2 cents in underpayment for every dollar of wage gain due to a minimum wage increase (see columns 7 and 8) when wages are reported

[17] The one exception is for the relationship between large minimum wage changes and employment in specifications in which we include controls for macroeconomic covariates. Our employment estimates can be compared to those reported in our complementary work (Clemens and Strain 2021) for samples consisting of individuals ages 16 to 21. The estimates' sensitivity to the inclusion of controls for states' overall economic conditions is quite similar to what we find in our earlier work. For interpreting results in the analysis presented here, the key point to bear in mind is that the increase in subminimum wage payment in states that enacted large minimum wage increases would likely, if anything, have been larger had there been no changes in low-skilled groups' employment. This reflects that, in a standard compliance model, the individuals who are prone to losing employment following a minimum wage increase will tend to be those who, under weaker enforcement regimes, could retain employment at a subminimum wage rate.

by a proxy respondent. For the much smaller sample with self-reported wages, the equivalent figure is 9.6 cents (see columns 3 and 4). Note that the proxy-sample's estimate of 14.2 cents falls within the confidence interval implied by the estimate of underpayment among self-respondents in column 4. For the full sample of individuals ages 16 to 65, we find 16.6 cents in underpayment for every dollar in wage gain among proxy respondents, as compared with 18.3 cents among self-respondents. Proxy respondents thus do not appear to be a source of disproportionately high degrees of underpayment.

To further analyze the potential relevance of measurement error, we look to measurement error's prospects for explaining several dimensions of the data we analyze. Here we emphasize several points. First, pure measurement error cannot explain heterogeneity in the pervasiveness of subminimum wage payment's response to minimum wage increases across states. That is, as a hypothesized explanation of the data, measurement error does not vary with economic features of the environment. Second, as a proposed explanation for the data, measurement error lacks testable content unless it is given additional structure. That is, a scientific inquiry into measurement error's potential role requires placing structure on the measurement error one wishes to investigate. We proceed along these lines by investigating whether our results can be explained by the measurement error model proposed by Autor, Manning, and Smith (2016), hereafter AMS, in their investigation of positive spillover effects of minimum wages.

In Appendix B, we investigate whether the AMS measurement error model can reproduce key patterns in the underpayment we observe in the data. We show that the AMS measurement error model does not match key patterns in either the observed distributions of subminimum wage payment or in the pervasiveness of payment at precisely the minimum wage. First, it

cannot explain the striking difference we observe when comparing states that have indexed their minimum wage rates for inflation to states that enacted minimum wage changes through new legislation. Note that this is not a criticism of the AMS model of measurement error, as the model was not proposed as an explanation for the phenomena we are analyzing. Further, as shown in a complementary analysis (Clemens and Strain, 2022) the AMS model significantly understates the magnitude of measured underpayment relative to the magnitude of measured positive spillovers for the young.

As shown in Table 3, we find substantial differences in subminimum wage payment in states that index their minimum wage rates for inflation relative to states that enacted higher minimum wage rates through new legislation. Measurement error in self-reported wage rates should not differ systematically between states that do and do not index their minimum wage rates for inflation. Put differently, measurement error is not a plausible explanation for the finding that firms and workers comply to a far greater degree with minimum wage increases that are regular and forecastable than with minimum wage increases enacted through new legislation. Similarly, measurement error cannot account for the patterns we observe when comparing subminimum wage payment on the margin in states with strong versus weak enforcement regimes.

In addition, Table B2 reveals that wages in states with inflation-indexing provisions are more likely than wages in states with new minimum wage legislation to coordinate around the minimum wage itself. This fact has multiple implications for models of measurement error. First, in the AMS model movement in the amount of mass at the minimum wage is used to infer what fraction of households report their wage rates with error. As a model of measurement error, the

AMS model does not have a basis for expecting this value to differ systematically across groups of states. In the data, however, these values differ dramatically when comparing inflation-indexing regimes to minimum wage changes driven by new legislation.

Second, the close tracking of wage rates to inflation-indexed minimum wages cuts directly against additional, standard models of measurement error. Inflation-indexed minimum wage changes tend to take irregular values while new statutes tend to set minimum wage rates at round numbers. The findings in Table B2 thus contrast with models of measurement error based on evidence that survey respondents tend to be far more capable of recalling round numbers (Schwabish, 2007; Gideon, Helppie-McFall, and Hsu 2017). Measurement error would tend to imply less faithful tracking of wage rates to the irregular values of minimum wages under inflation-indexing regimes. Put differently, results driven by measurement error would show greater divergence of self-reported wages from the minimum following minimum wage increases under inflation-indexing regimes. We observe the opposite. We refer readers to Appendix B for additional analysis and discussion of measurement error.

Finally, Cengiz *et al.* (2019) find that measurement error may play a much smaller role in generating CPS observations with subminimum wages than one might expect. Cengiz *et al.* (2019) compare CPS wage distributions to data from three states in which wage distributions can be inferred from administrative unemployment records. Rates of subminimum wage payment turn out to be similar in the administrative wage data as in the CPS.[18]

[18] As Cengiz et al (2019) write in Appendix F: "The distributions from the CPS closely match the distributions in the administrative data in all states and in all three five-years periods (2000-2004, 2005-2009, and 2010-2014). A similar number of jobs are present just below the minimum wage in the two data sources, albeit in some cases there are slightly more in the CPS (e.g. in WA 2005-2009). When we pool all three states, the CPS and the administrative data exhibit virtually the same distribution below the minimum wage."

Section VI: Discussion and Conclusion

A holistic assessment of the labor market effects of minimum wage regulation requires understanding employer compliance. This paper attempts to further economists' understanding of subminimum wage payment by investigating the extent to which subminimum wage payment rises in response to increases in the minimum wage. We find strong evidence that higher minimum wages lead to a greater prevalence of subminimum wage payment. We consistently estimate that increases in measured underpayment average between 12 and 17 percent of realized wage gains following minimum wage increases. We interpret this as evidence that minimum wage evasion and avoidance are an important reality in the low-wage labor market.

Our second key finding is that subminimum wage payment has risen substantially in the wake of newly legislated minimum wage increases, but not in the wake of the regular and forecastable minimum wage increases driven by inflation-indexing provisions. As reported in Figure 3, rates of subminimum wage payment rose steadily in the wake of minimum wage increases enacted through new legislation. For 16-to-25-year-old wage earners, rates of subminimum wage payment had risen, on average, by just under 10 percentage points within three years of minimum wage changes driven by new legislation. By contrast, rates of subminimum wage payment had not risen at all under inflation-indexing regimes. This may reflect the fact that firms operating under inflation-indexing regimes may have more fully responded along other margins, potentially including employment, when their inflation-indexing regimes initially went into effect (Brummund and Strain, 2020). As an additional caveat, we note that the effects of inflation-indexing regimes may differ during periods of high and/or rising

inflation in comparison with periods of low and stable inflation, which describes the time period we study here.

The absence of a rise in subminimum wage payment following inflation-indexed changes in minimum wages suggests that compliance will tend to be higher when minimum wage increases are modest and scheduled well in advance, such that forward-looking firms can plan accordingly. In addition, it provides strong evidence against the possibility that measurement error is the key driver of our results. Specifically, it reveals that there is a class of states for which minimum wage increases are not associated with increases in measured subminimum wage payment. This provides direct evidence against the concern the measurement error generates a mechanical correlation between minimum wage increases and measured subminimum wage payment.

Similarly, we note a contrast between the dynamic effect of "small" and "large" statutory increases on subminimum wage payment. For relatively "small" increases, noncompliance increases for 2-3 years following the enactment of new legislation but declines thereafter. The dynamic profile suggests that some firms' initial response to minimum wage increases included noncompliance, but that compliance may improve as firms are able to adjust to higher labor costs more fully along other margins. In contrast, we find that noncompliance had plateaued but not yet begun to decline by the end of our sample in response to relatively "large" minimum wage increases. Firms' adjustments to these larger increases may take more time to unfold.

Our results suggest that minimum wage increases both raise wages among the employed and increase the prevalence of subminimum wage payment. Recent papers by Garnero and Lucifora (forthcoming) and by Badaoui and Walsh (2022) have emphasized a trade-off between

compliance and the minimum wage's effects on employment. As discussed by Clemens (2021), noncompliance is among the many adjustment margins to which firms might look before reducing their hiring or resorting to firing workers. Aggressive measures to enforce compliance may thus reduce evasion but may also risk reducing employment and possibly worker earnings. This points to a tension policymakers must weigh as they debate the appropriate level of the statutory wage floor.

The rule of law requires that employers pay workers what they are owed under minimum wage regulations. At the same time, strict enforcement of the minimum wage may preclude some workers and employers from entering into mutually beneficial contracts. Put differently, evasion may, in some cases, mitigate the minimum wage's employment effects. The trade-off between economic efficiency and respect for the rule of law is not one to be taken lightly. Our findings highlight that an appreciation of this trade-off, along with empirical assessments of the prevalence and drivers of subminimum wage payment, is important in fully evaluating the labor market effects of minimum wages.

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Table 1. 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 come from the National Council of State Legislatures. The states labeled as "indexers" link annual updates to their minimum wage rates to a measure of inflation. Data on minimum wage changes come 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 2. Sample Summary Statistics: CPS MORG and Supplemental Data for 2011–2013 and 2016–2019

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Years	2011–2013	2016–2019	2011–2013	2016–2019	2011–2013	2016–2019	2011–2013	2016–2019
Sample	Ages 16–25		Employed Ages 16–25		Hourly Not Imputed		Hourly Not Imputed No Subrates No Exempt	
Subminimum Wage Payment	0.0192	0.0334	0.0404	0.0639	0.0248	0.0434	0.0264	0.0265
	(0.137)	(0.180)	(0.197)	(0.245)	(0.155)	(0.204)	(0.160)	(0.161)
Underpayment ($)	0.0401	0.0675	0.0845	0.129	0.0499	0.0640	0.0576	0.0525
	(0.360)	(0.481)	(0.519)	(0.660)	(0.387)	(0.416)	(0.431)	(0.415)
Employment	0.484	0.530	1	1	1	1	1	1
	(0.500)	(0.499)	(0)	(0)	(0)	(0)	(0)	(0)
Age	20.50	20.53	21.65	21.61	21.23	21.09	21.16	21.05
	(2.873)	(2.913)	(2.471)	(2.553)	(2.506)	(2.618)	(2.538)	(2.643)
Black	0.152	0.151	0.119	0.134	0.118	0.126	0.140	0.145
	(0.359)	(0.358)	(0.323)	(0.341)	(0.322)	(0.332)	(0.347)	(0.352)
High School Degree	0.243	0.253	0.278	0.298	0.292	0.302	0.301	0.307
	(0.429)	(0.435)	(0.448)	(0.458)	(0.455)	(0.459)	(0.458)	(0.461)
Some College Education	0.333	0.322	0.409	0.375	0.430	0.403	0.417	0.391
	(0.471)	(0.467)	(0.492)	(0.484)	(0.495)	(0.491)	(0.493)	(0.488)
Galvin Enforcement Index	0.245	0.243	0.245	0.243	0.248	0.246	0.217	0.217
	(0.0904)	(0.0899)	(0.0883)	(0.0881)	(0.0880)	(0.0850)	(0.0846)	(0.0812)
Galvin Only Penalties Index	0.286	0.283	0.285	0.282	0.291	0.288	0.249	0.250
	(0.138)	(0.137)	(0.135)	(0.134)	(0.135)	(0.131)	(0.125)	(0.120)
House Price Index	332.6	433.7	329.3	429.1	324.0	420.7	297.1	374.5
	(102.8)	(138.8)	(101.1)	(136.6)	(96.30)	(132.1)	(86.71)	(104.3)
Income Per Capita ($1000s)	44.21	53.24	44.18	53.03	43.86	52.52	42.61	50.22
	(6.420)	(8.815)	(6.345)	(8.638)	(6.111)	(8.267)	(6.111)	(7.341)
Effective Minimum Wage ($)	7.542	8.614	7.532	8.575	7.540	8.538	7.372	7.882
	(0.426)	(1.481)	(0.424)	(1.465)	(0.433)	(1.448)	(0.243)	(0.989)
Observations	149,893	179,562	71,133	91,748	34,394	40,149	23,062	28,334

Notes: This table reports summary statistics for four sample groups. Columns 1 and 2 report averages and standard deviations (in parentheses) of each of the variables for our full sample of individuals ages 16 to 25. Columns 3 and 4 report averages and standard deviations (in parenthesis) for our subsample of employed individuals ages 16 to 25. Columns 5 and 6 report averages and standard deviations (in parenthesis) for our restricted subsample of employed individuals ages 16 to 25 who are paid by the hour; do not receive overtime, tips, or commissions, and do not have imputed wage rates. Columns 7 and 8 report averages and standard deviations (in parenthesis) for our most restricted subsample of employed individuals ages 16 to 25 who are paid by the hour; do not receive overtime, tips, or commissions; do not have imputed wage rates, do not live in states with substate minimum wage rates; and do not work in occupations potentially exempt from the minimum wage. Entries for employment, age, race, and education summarize data from the Current Population Survey Merged Outgoing Rotation Groups (CPS MORG). The enforcement and only penalties indices come from Galvin (2016) and are discussed further in the paper. The house price index variable uses data from the quarterly all transactions state index published by the Federal Housing Finance Agency (FHFA). The income per capita variable uses average quarterly data by state from the Bureau of Economic Analysis (BEA). The effective minimum wage variable is the maximum of the state and federal minimum wage for large employers and uses data from the U.S. Department of Labor.

Table 3. Relationship Between Minimum Wage Increases and Subminimum Wage Payment Across Samples of the CPS MORG Using Minimum Wage Policy Categories

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sample	Employed		Hourly		Not Imputed		Not Imputed No Subrates or Exempt	
Large Statutory Increaser x Post	0.1140***	0.0935***	0.1515***	0.1234***	0.0950***	0.0660***	0.0756***	0.0723***
	(0.0104)	(0.0109)	(0.0112)	(0.0131)	(0.0110)	(0.0081)	(0.0094)	(0.0066)
Small Statutory Increaser x Post	0.0784***	0.0783***	0.0990***	0.0980***	0.0693***	0.0673***	0.0541***	0.0539***
	(0.0090)	(0.0084)	(0.0125)	(0.0114)	(0.0125)	(0.0114)	(0.0062)	(0.0074)
Indexer x Post	0.0168	0.0019	0.0198	0.0010	0.0065	-0.0105	-0.0145	-0.0187
	(0.0126)	(0.0113)	(0.0181)	(0.0161)	(0.0168)	(0.0138)	(0.0126)	(0.0127)
Ln(Income per Capita)		-0.0626		-0.0657		-0.0183		0.0126
		(0.0979)		(0.1338)		(0.0747)		(0.0574)
House Price Index Divided by 1000		0.2887***		0.3579***		0.3153***		0.1268
		(0.0765)		(0.1034)		(0.0742)		(0.0811)
State prime-age emp-to-pop ratio		-0.0163		-0.0270		-0.0233		-0.0180
		(0.0235)		(0.0257)		(0.0309)		(0.0275)
Age and education controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	162,881	162,881	116,776	116,776	74,543	74,543	51,396	51,396

Notes: This table reports regression results examining the effect of minimum wage increases on subminimum wage payment. The dependent variable is an indicator for whether an individual's reported hourly wages are more than $0.25 below the effective minimum wage. The sample is from the CPS MORG and consists of all individuals ages 16 to 25. Columns 1 and 2 include all individuals who are employed, columns 3 and 4 include all individuals who are employed; paid by the hour; and do not receive overtime, tips, or commissions; and columns 5 and 6 include all individuals who are employed; paid by the hour; do not receive overtime, tips, or commissions; and do not have imputed wage rates. Columns 7 and 8 include all individuals who are employed; paid by the hour; do not receive overtime, tips, or commissions; do not have imputed wage rates, do not live in states with substate minimum wage rates, and do not work in occupations potentially exempt from the minimum wage 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. Age and education controls consist of a dummy variable for each education group and age. Standard errors are clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1

Table 4: Relationship Between Minimum Wage Increases Average Hourly Wage Increases and Subminimum Payment Among Individuals Ages 16–25, Ages 16–35, Ages 16–65, and Ages 16–21 Using Continuous Minimum Wage Variation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sample	Ages 16–25		Ages 16–35		Ages 16–65		Ages 16–21	
Dependent variable	Hourly Wage	Underpayment	Hourly Wage	Underpayment	Hourly Wage	Underpayment	Hourly Wage	Underpayment
Effective Minimum Wage	0.2934***	0.0357***	0.1633***	0.0261***	0.1027***	0.0174***	0.3841***	0.0526***
	(0.0352)	(0.0037)	(0.0261)	(0.0029)	(0.0240)	(0.0029)	(0.0359)	(0.0055)
Ln(Income per Capita)	0.7836	-0.0345	0.8789	-0.0329	-0.0803	0.0151	1.0544	-0.0343
	(0.8602)	(0.1365)	(0.6907)	(0.0820)	(0.5693)	(0.0606)	(0.8090)	(0.1957)
House Price Index Divided by 1000	0.3567	0.0206	0.0451	-0.0112	0.4408	0.0060	0.9315	-0.0733
	(0.7600)	(0.0873)	(0.6213)	(0.0560)	(0.5388)	(0.0543)	(0.7122)	(0.1373)
State prime-age emp-to-pop ratio	0.5488**	0.0156	0.4528*	0.0177	0.2517	0.0095	0.3201	0.0348
	(0.2672)	(0.0489)	(0.2382)	(0.0376)	(0.1747)	(0.0319)	(0.3406)	(0.0662)
Observations	96,095	96,095	189,075	189,075	409,121	409,121	52,065	52,065

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 more than $0.25 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 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 individuals ages 16–25, Columns 3 and 4 display estimates of the effect of minimum wage changes on average hourly wages and underpayment among individuals ages 16–35, Columns 5 and 6 display estimates of the effect of minimum wage changes on average hourly wages and underpayment among individuals ages 16–65, and Columns 7 and 8 display estimates of the effect of minimum wage changes on average hourly wages and underpayment among individuals ages 16–21. 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. Age and education controls consist of a dummy variable for each education group and age. Standard errors are clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1

Table 5. Relationship Between Minimum Wage Increases, Enforcement and Subminimum Wage Payment Using Continuous Minimum Wage Changes, and Full Enforcement Index 2011–2019

	(1)	(2)	(3)	(4)
Dependent Variable	Paid > $0.25 below effective minimum wage		Underpayment	
Effective Minimum Wage	0.0072	0.0072	0.0194**	0.0199**
	(0.0089)	(0.0089)	(0.0075)	(0.0075)
Effective Minimum Wage x Galvin Enforcement Index	0.0841***	0.0897***	0.0510***	0.0530***
	(0.0266)	(0.0292)	(0.0180)	(0.0195)
Ln(Income per Capita)		-0.1140		-0.0617
		(0.0720)		(0.1361)
House Price Index Divided by 1000		0.0119		-0.0018
		(0.0782)		(0.0831)
State prime-age emp-to-pop ratio		0.0018		0.0178
		(0.0260)		(0.0488)
Age and education controls	No	Yes	No	Yes
Observations	96,095	96,095	96,095	96,095

Notes: This table reports regression results examining the effect of minimum wage increases and enforcement on subminimum wage payment and underpayment. The sample is from the CPS MORG and consists of all individuals ages 16 to 25 who are employed; paid by the hour; do not receive overtime, tips, or commissions; and do not have imputed wage rates. The dependent variable is an indicator for whether an individual's reported hourly wage is more than $0.25 below the effective minimum wage in Columns 1 and 2, and the amount of reported underpayment for individuals with reported hourly wages below the effective minimum wage in Columns 3 and 4. 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. Age and education controls consist of a dummy variable for each education group and age. Standard errors are clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1

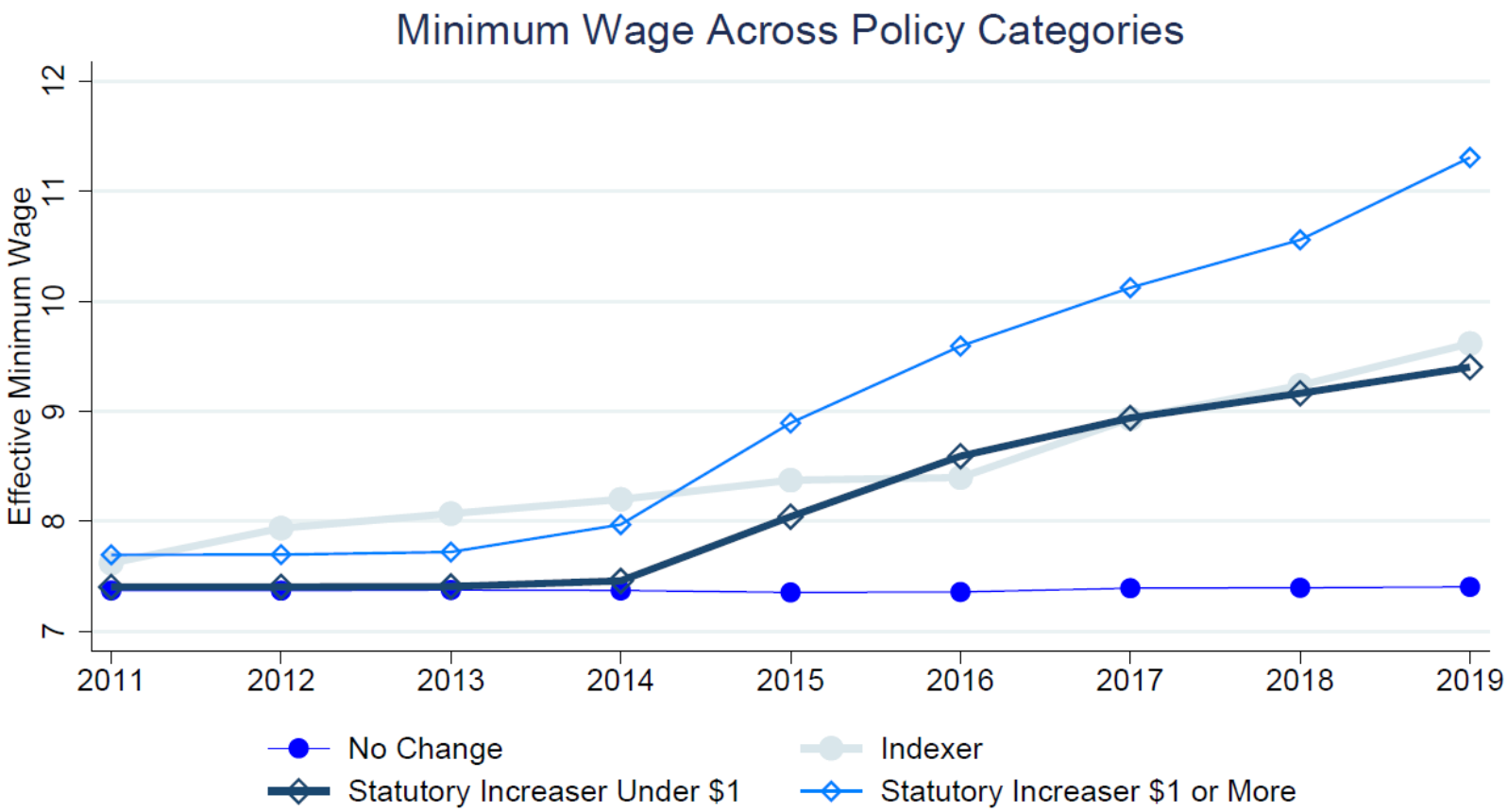

Figure 1. Average Minimum Wage Across Original Policy Categories. This figure plots the average annual effective minimum wage for states in each of our four policy categories from January 2011 to January 2019. States are defined as statutory increasers under $1 if the combined statutory increase in their minimum wage between January 2013 and January 2015 was under $1. States are defined as statutory increasers of $1 or more if the combined statutory increase in their minimum wage was $1 or greater. Indexers are states that index their minimum wage to inflation. The effective minimum wage is defined as the maximum of the state and federal minimum wage. Data on minimum wage rates come from the U.S. Department of Labor. Data on minimum wage policies come primarily from the National Conference of State Legislatures and the U.S. Department of Labor. Averages are weighted by state population.

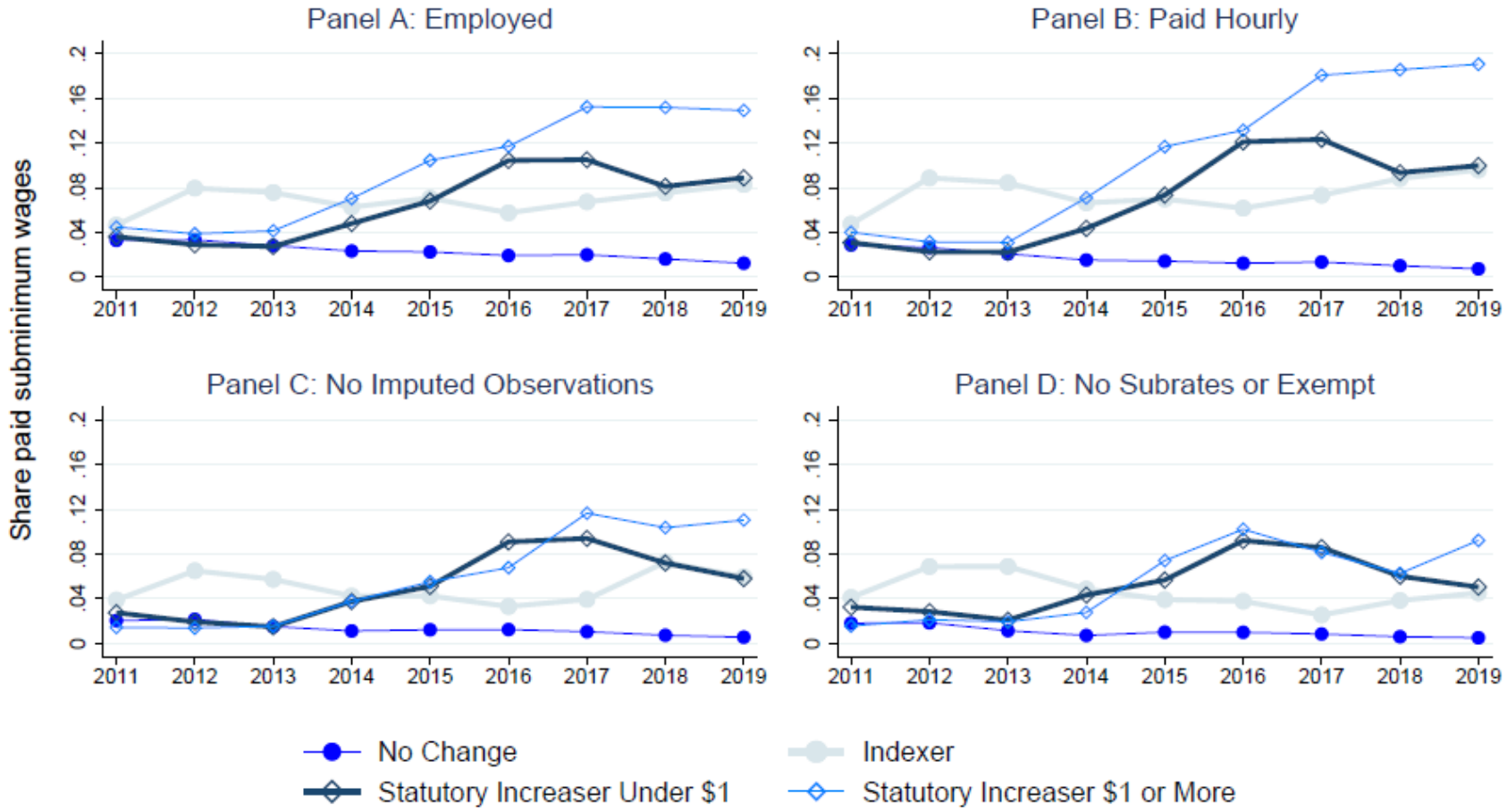

Figure 2. Incidence of Subminimum Wage Payment Across Original Policy Categories Ages 16–25. This figure plots the share of individuals who reported hourly wages more than $0.25 below the effective minimum wage for each of our four policy groups, broken out across four subsamples, from 2011 to 2019. Data come from the Current Population Survey Merged Outgoing Rotation Groups (CPS MORG). Panel A includes all individuals ages 16–25 who are employed. Panel B restricts the sample to all individuals who are employed; paid by the hour; and do not receive overtime, tips, or commissions. Panel C restricts the sample to all individuals who are employed; paid by the hour; do not receive overtime, tips, or commissions; and whose wage rates are not imputed. Panel D restricts the sample to all individuals who are employed; paid by the hour; do not receive overtime, tips, or commissions; whose wage rates are not imputed; who do not live in states with local minimum wage rates; and who do not work in occupations exempt from the federal minimum wage. States are defined as statutory increasers under $1 if the combined statutory increase in their minimum wage between January 2013 and January 2015 was under $1. States are defined as statutory increasers of $1 or more if the combined statutory increase in their minimum wage was $1 or greater. Indexers are states that index their minimum wage to inflation. Averages are weighted by state population.

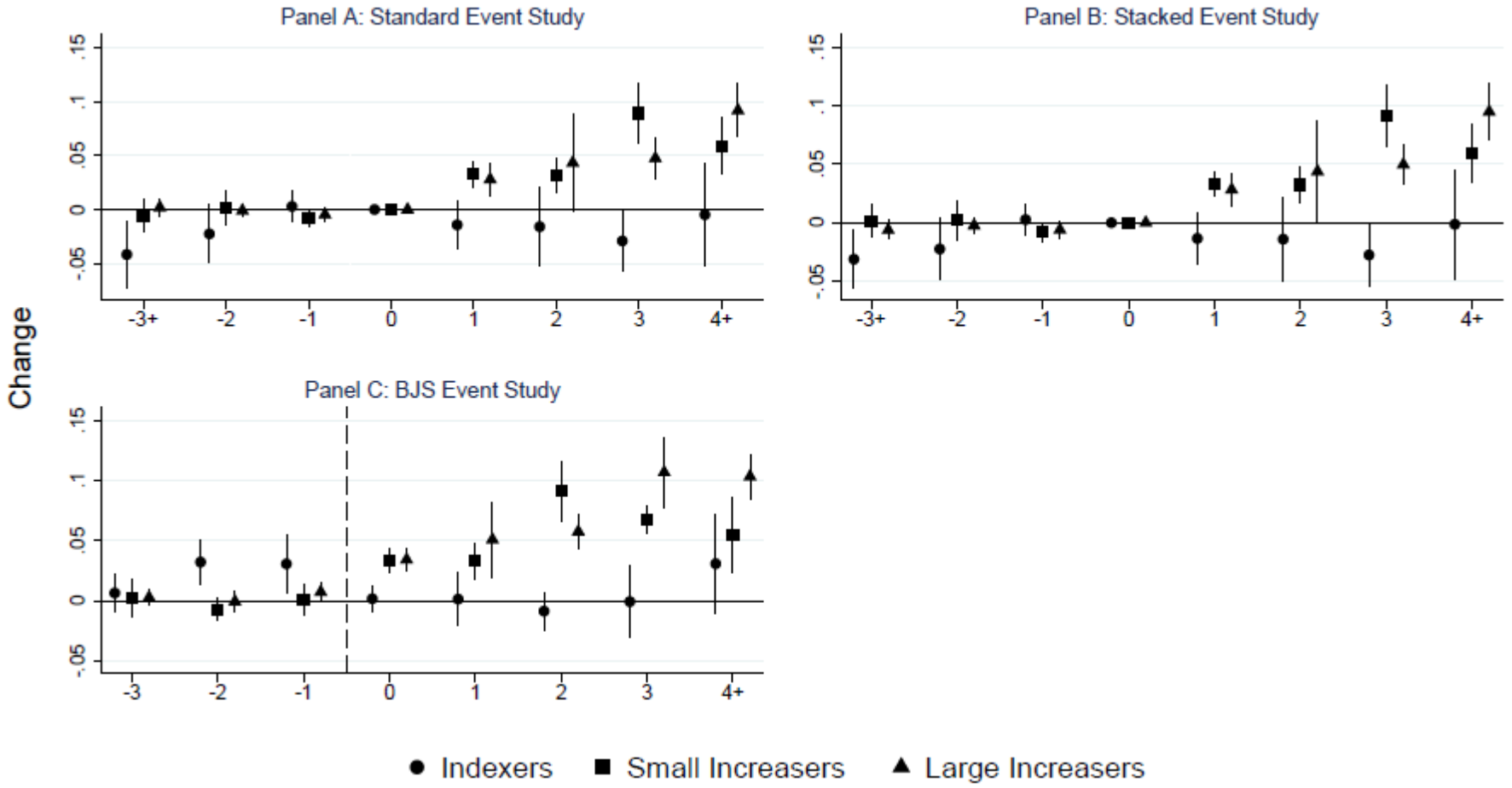

Figure 3. Event Studies of Changes in Subminimum Wage Payment For Individuals Ages 16–25 Following Initial Minimum Wage Increases Using Various Event Study Estimators. This figure displays coefficients obtained from different event study estimators. Panel A displays results using the event study estimator in equation 2, Panel B displays results using the stacked event study estimator. Panel C displays results using the imputation estimator proposed by Borusyak, Jaravel, and Spiess (2021) (BJS). For all panels, the sample consists of all individuals ages 16–25 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 are presented separately for minimum wage increases that were driven by inflation-indexing provisions ("indexer"), that involved "large" new statutory increases, and that involved "small" new statutory increases. 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 minimum wage increase occurred. The year of the initial increase is period 1 for the standard and stacked estimators in panels A and B, and period 0 for the BJS estimator in Panel C. For small and large increaser states, period 1 represents the year the first minimum wage increase took effect. For indexer states, period 1 corresponds to the year 2014. Error bars denote 95 percent confidence intervals around each estimated coefficient. Standard errors are clustered by state.

Appendix A: Additional Tables and Figures

Table A1: List of States with Statutory Minimum Wage Increases and Inflation-Indexed Increases Using Changes from 2013 to 2017 and $2 Cutoff

Statutory increasers of $2 or more	Statutory increasers under $2
Alaska	Arkansas
Arizona	Colorado
California	Connecticut
District of Columbia	Delaware
Hawaii	Maine
Massachusetts	Maryland
Minnesota	Michigan
New York	Nebraska
	New Jersey
	Oregon
Indexers	Rhode Island
Florida	South Dakota
Missouri	Vermont
Montana	Washington
Ohio	West Virginia

Notes: Data on minimum wage indexing provisions come 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 come from the U.S. Department of Labor. States are counted as statutory increasers of under $2 if the combined statutory increase in the minimum wage from January 2013 through January 2017 was under $2. States are counted as statutory increasers of $2 or more if the combined statutory increase in the minimum wage was $2 or more.

Table A2. Unadjusted Differences Across Policy Regimes Using CPS MORG Data for 2011–2013 and 2016–2019

	(1)	(2)	(3)	(4)
	2011–2013	2016–2019	Change	Change Relative to Non-increasers
Subminimum Wage Payment				
Non-Increasers	0.0190	0.00892	-0.010	
Indexers	0.0539	0.0512	-0.003	0.007
Increase < $1	0.0206	0.0791	0.059	0.069
Increase >= $1	0.0145	0.0987	0.084	0.094
Underpayment ($)				
Non-Increasers	0.0541	0.0364	-0.018	
Indexers	0.0601	0.0671	0.007	0.025
Increase < $1	0.0490	0.0985	0.050	0.067
Increase >= $1	0.0329	0.108	0.075	0.093
Employment Ages 16–25				
Non-Increasers	0.496	0.540	0.044	
Indexers	0.497	0.551	0.054	0.010
Increase < $1	0.516	0.561	0.045	0.007
Increase >= $1	0.440	0.482	0.042	-0.004
Prime Age Employment				
Non-Increasers	0.760	0.790	0.030	
Indexers	0.757	0.794	0.037	0.007
Increase < $1	0.770	0.806	0.036	0.006
Increase >= $1	0.746	0.783	0.037	0.007
House Price Index				
Non-Increasers	279.9	348.5	68.6	
Indexers	291.1	424.2	133.1	64.5
Increase < $1	304.9	372.5	67.6	-1.0
Increase >= $1	466.2	627.6	161.4	92.8
Income per Capita ($1000s)				
Non-Increasers	41.26	48.58	7.32	
Indexers	40.99	49.96	8.97	1.65
Increase < $1	45.55	54.01	8.46	1.14
Increase >= $1	51.11	64.28	13.17	5.85

Notes: This table reports changes in employment rates subminimum wage payment, and underpayment for each our of our four policy groups (non-increasers, indexers, increase < $1, and increase >= $1) between our pre and post periods. Prime age adults are defined as individuals between the ages of 26 and 54. The mean values for subminimum wage payment and underpayment are calculated on the baseline analysis sample of all individuals ages 16–25 who are employed, paid hourly, do not receive overtime, tips, or commissions, and do not have imputed wage rates. This table also reports mean values of economic control variables (house price index and income per capita) for each of our four policy groups. Data sources are more fully described in the note to Table 2. Column 1 reports the average value between 2011 and 2013 for each row, column 2 reports the average value between 2016 and 2019, and column 3 reports the difference between the two. Column 4 reports the change in the average value for each row relative to the relevant non-increaser value. Averages are weighted by state population.

Table A3. Relationship Between Minimum Wage Increases and Subminimum Wage Payment Across Samples of the CPS MORG Using Continuous Minimum Wage Changes

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sample	Employed		Hourly		Not Imputed		Not Imputed No Subrates No Exempt	
Effective Minimum Wage	0.0389***	0.0402***	0.0524***	0.0542***	0.0340***	0.0338***	0.0254***	0.0274***
	(0.0024)	(0.0025)	(0.0032)	(0.0039)	(0.0033)	(0.0028)	(0.0036)	(0.0039)
Ln(Income per Capita)		-0.0538		-0.0740		-0.0680		0.0162
		(0.0688)		(0.0940)		(0.0746)		(0.0629)
House Price Index Divided by 1000		0.0064		-0.0066		0.0498		-0.1031
		(0.0864)		(0.1160)		(0.0999)		(0.1207)
State prime-age emp-to-pop ratio		-0.0062		-0.0143		-0.0019		0.0094
		(0.0246)		(0.0254)		(0.0258)		(0.0239)
Age and education controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	210,816	210,816	151,133	151,133	96,095	96,095	66,191	66,191

Notes: This table reports regression results examining the effect of minimum wage increases on subminimum wage payment, measuring minimum wage changes as a continuous variable. The dependent variable is an indicator for whether an individual's reported hourly wages are more than $0.25 below the effective minimum wage. The sample is from the CPS MORG and consists of all individuals ages 16 to 25. Columns 1 and 2 include all individuals who are employed, columns 3 and 4 include all individuals who are employed; paid by the hour; and do not receive overtime, tips, or commissions; and columns 5 and 6 include all individuals who are employed; paid by the hour; do not receive overtime, tips, or commissions; and do not have imputed wage rates. Columns 7 and 8 include all individuals who are employed; paid by the hour; do not receive overtime, tips, or commissions; do not have imputed wage rates, do not live in states with substate minimum wage rates, and do not work in occupations potentially exempt from the minimum wage. 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. Age and education controls consist of a dummy variable for each education group and age. Standard errors are clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1

Table A4. Relationship Between Minimum Wage Increases and Subminimum Wage Payment Across Samples of the CPS MORG Ages 16–21 Using Minimum Wage Policy Categories

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sample	Employed		Hourly		Not Imputed		Not Imputed No Subrates or Exempt	
Large Statutory Increaser x Post	0.1564***	0.1314***	0.1860***	0.1561***	0.1280***	0.0958***	0.1143***	0.1106***
	(0.0109)	(0.0160)	(0.0124)	(0.0188)	(0.0086)	(0.0130)	(0.0123)	(0.0104)
Small Statutory Increaser x Post	0.1130***	0.1130***	0.1342***	0.1349***	0.1014***	0.1014***	0.0778***	0.0778***
	(0.0160)	(0.0154)	(0.0195)	(0.0185)	(0.0180)	(0.0172)	(0.0086)	(0.0100)
Indexer x Post	0.0169	0.0001	0.0223	0.0029	0.0046	-0.0129	-0.0243	-0.0269
	(0.0215)	(0.0199)	(0.0276)	(0.0249)	(0.0245)	(0.0216)	(0.0203)	(0.0214)
Ln(Income per Capita)		-0.1473		-0.1430		-0.0460		0.0310
		(0.1549)		(0.1957)		(0.1213)		(0.0858)
House Price Index Divided by 1000		0.3863***		0.4344***		0.3744***		0.1026
		(0.1213)		(0.1540)		(0.1175)		(0.1304)
State prime-age emp-to-pop ratio		-0.0085		-0.0256		-0.0436		0.0074
		(0.0373)		(0.0360)		(0.0424)		(0.0446)
Age and education controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	75,252	75,252	61,419	61,419	40,579	40,579	28,186	28,186

Notes: This table reports regression results examining the effect of minimum wage increases on subminimum wage payment. The dependent variable is an indicator for whether an individual's reported hourly wages are more than $0.25 below the effective minimum wage. The sample is from the CPS MORG and consists of all individuals ages 16 to 21. Columns 1 and 2 include all individuals who are employed, columns 3 and 4 include all individuals who are employed; paid by the hour; and do not receive overtime, tips, or commissions; and columns 5 and 6 include all individuals who are employed; paid by the hour; do not receive overtime, tips, or commissions; and do not have imputed wage rates. Columns 7 and 8 include all individuals who are employed; paid by the hour; do not receive overtime, tips, or commissions; do not have imputed wage rates, do not live in states with substate minimum wage rates, and do not work in occupations potentially exempt from the minimum wage. Variable definitions and sources are discussed in the note to Table 2 (and in the paper). All specifications include year and state fixed effects. Age and education controls consist of a dummy variable for each education group and age. Standard errors are clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1

Table A5. Relationship Between Minimum Wage Increases, Average Hourly Wage Increases, and Underpayment Among Individuals Ages 16–65 and Ages 16–21 With Self-Reported and Proxy-Reported Labor Force Status Using Continuous Minimum Wage Variation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sample	Ages 16–65 Self-Reported		Ages 16–21 Self-Reported		Ages 16–65 Proxy Reported		Ages 16–21 Proxy Reported	
Dependent Variable	Hourly Wage	Underpayment	Hourly Wage	Underpayment	Hourly Wage	Underpayment	Hourly Wage	Underpayment
Effective Minimum Wage	0.0393	0.0072**	0.2721***	0.0262**	0.1674***	0.0278***	0.4091***	0.0583***
	(0.0253)	(0.0033)	(0.0741)	(0.0099)	(0.0238)	(0.0033)	(0.0344)	(0.0060)
Ln(Income per Capita)	-0.8329	0.1136*	1.4138	0.1878	0.6369	-0.0919	1.2133	-0.0703
	(0.5794)	(0.0621)	(1.5569)	(0.2827)	(0.6869)	(0.1006)	(0.7734)	(0.2056)
House Price Index Divided by 1000	0.7031	-0.0142	2.3119	-0.3606	0.0523	0.0261	0.4599	-0.0134
	(0.5385)	(0.0642)	(1.5036)	(0.2871)	(0.5900)	(0.0686)	(0.7458)	(0.1357)
State prime-age emp-to-pop ratio	0.2682	0.0070	1.0776	0.2174	0.2670	0.0092	0.1971	-0.0067
	(0.2392)	(0.0315)	(0.9102)	(0.1736)	(0.1864)	(0.0401)	(0.3575)	(0.0715)
Observations	211,964	211,964	8,961	8,961	197,157	197,157	43,104	43,104

Notes: This table reports regression results examining the effect of minimum wage increases on average hourly wages and underpayment for workers whose responses were self-reported and workers whose information was reported by a proxy respondent. 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 more than $0.25 below the effective minimum wage in Columns 2, 4, 6, and 8. The sample is from the CPS MORG and consists of individuals of various age groups 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 subminimum payment among self-reporting individuals ages 16–65, Columns 3 and 4 display estimates of the effect of minimum wage changes on average hourly wages and subminimum payment among proxy-reporting individuals ages 16–65, Columns 5 and 6 display estimates of the effect of minimum wage changes on average hourly wages and subminimum payment among self-reporting individuals ages 16–21, and Columns 7 and 8 display estimates of the effect of minimum wage changes on average hourly wages and subminimum payment among proxy-reporting individuals ages 16–21. 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. All regressions include 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

Table A6. Relationship Between Minimum Wage Increases and Subminimum Wage Payment Across Samples of the CPS MORG Ages 16–65 Using Minimum Wage Policy Categories

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sample	Employed		Hourly		Not Imputed		Not Imputed No Subrates or Exempt	
Large Statutory Increaser x Post	0.0484***	0.0392***	0.0802***	0.0660***	0.0500***	0.0378***	0.0345***	0.0348***
	(0.0047)	(0.0051)	(0.0062)	(0.0079)	(0.0062)	(0.0032)	(0.0032)	(0.0032)
Small Statutory Increaser x Post	0.0251***	0.0249***	0.0383***	0.0386***	0.0253***	0.0253***	0.0204***	0.0206***
	(0.0023)	(0.0027)	(0.0046)	(0.0049)	(0.0045)	(0.0047)	(0.0036)	(0.0039)
Indexer x Post	0.0086*	0.0014	0.0106	0.0006	0.0048	-0.0026	-0.0042	-0.0045
	(0.0048)	(0.0044)	(0.0089)	(0.0082)	(0.0067)	(0.0058)	(0.0049)	(0.0047)
Ln(Income per Capita)		-0.0068		-0.0220		-0.0084		-0.0028
		(0.0355)		(0.0641)		(0.0350)		(0.0252)
House Price Index Divided by 1000		0.1138***		0.1735***		0.1337***		0.0220
		(0.0313)		(0.0549)		(0.0359)		(0.0401)
State prime-age emp-to-pop ratio		-0.0053		-0.0174		-0.0119		-0.0204
		(0.0081)		(0.0126)		(0.0149)		(0.0122)
Age and education controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	1,071,612	1,071,612	532,713	532,713	318,431	318,431	217,729	217,729

Notes: This table reports regression results examining the effect of minimum wage increases on subminimum wage payment. The dependent variable is an indicator for whether an individual's reported hourly wages are more than $0.25 below the effective minimum wage. The sample is from the CPS MORG and consists of all individuals ages 16 to 65. Columns 1 and 2 include all individuals who are employed, columns 3 and 4 include all individuals who are employed; paid by the hour; and do not receive overtime, tips, or commissions; and columns 5 and 6 include all individuals who are employed; paid by the hour; do not receive overtime, tips, or commissions; and do not have imputed wage rates. Columns 7 and 8 include all individuals who are employed; paid by the hour; do not receive overtime, tips, or commissions; do not have imputed wage rates, do not live in states with substate minimum wage rates, and do not work in occupations potentially exempt from the minimum wage. Variable definitions and sources are discussed in the note to Table 2 (and in the paper). All specifications include year and state fixed effects. Age and education controls consist of a dummy variable for each education group and age. Standard errors are clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1

Table A7. Relationship Between Minimum Wage Increases and Subminimum Wage Payment Across Samples of the CPS MORG Using Minimum Wage Policy Categories and Including Census Region X Time Fixed Effects

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sample	Employed		Hourly		Not Imputed		Not Imputed No Subrates or Exempt	
Large Statutory Increaser x Post	0.1010***	0.0883***	0.1345***	0.1165***	0.0799***	0.0659***	0.0749***	0.0694***
	(0.0097)	(0.0121)	(0.0120)	(0.0136)	(0.0082)	(0.0110)	(0.0111)	(0.0086)
Small Statutory Increaser x Post	0.0830***	0.0806***	0.1048***	0.1007***	0.0723***	0.0680***	0.0554***	0.0540***
	(0.0099)	(0.0090)	(0.0140)	(0.0122)	(0.0125)	(0.0109)	(0.0075)	(0.0088)
Indexer x Post	0.0110	0.0031	0.0131	0.0026	-0.0035	-0.0104	-0.0142	-0.0184
	(0.0092)	(0.0114)	(0.0143)	(0.0164)	(0.0121)	(0.0129)	(0.0103)	(0.0117)
Ln(Income per Capita)		-0.1322		-0.1483		-0.0855		-0.0310
		(0.0850)		(0.1139)		(0.0771)		(0.0683)
House Price Index Divided by 1000		0.2647***		0.3409***		0.2473**		0.1345
		(0.0927)		(0.1239)		(0.0986)		(0.0798)
State prime-age emp-to-pop ratio		-0.0195		-0.0271		-0.0143		-0.0183
		(0.0240)		(0.0271)		(0.0326)		(0.0295)
Age and education controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	162,881	162,881	116,776	116,776	74,543	74,543	51,396	51,396

Notes: This table reports regression results examining the effect of minimum wage increases on subminimum wage payment. The dependent variable is the an indicator for whether an individual's reported hourly wages are more than $0.25 below the effective minimum wage. The sample is from the CPS MORG and consists of all individuals ages 16 to 25. Columns 1 and 2 include all individuals who are employed; columns 3 and 4 include all individuals who are employed; paid by the hour; and do not receive overtime, tips, or commissions; and columns 5 and 6 include all individuals who are employed; paid by the hour; do not receive overtime, tips, or commissions; and do not have imputed wage rates. Columns 7 and 8 include all individuals who are employed; paid by the hour; do not receive overtime, tips, or commissions; do not have imputed wage rates; do not live in states with substate minimum wage rates; and do not work in occupations potentially exempt from the minimum wage. 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 Census region-month-year fixed effects. Age and education controls consist of a dummy variable for each education group and age. Standard errors are clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1

Table A8. Relationship Between Minimum Wage Increases, Average Hourly Wage Increases, and Underpayment Among Individuals Ages 16–25, Ages 16–35, Ages 16–65, and Ages 16–21 Using Continuous Minimum Wage Variation and Including Census Region X Time Fixed Effects

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sample	Ages 16–25		Ages 16–35		Ages 16–65		Ages 16–21	
Dependent Variable	Hourly Wage	Underpayment	Hourly Wage	Underpayment	Hourly Wage	Underpayment	Hourly Wage	Underpayment
Effective Minimum Wage	0.2628***	0.0377***	0.1594***	0.0280***	0.1076***	0.0189***	0.3432***	0.0539***
	(0.0326)	(0.0039)	(0.0287)	(0.0027)	(0.0247)	(0.0022)	(0.0318)	(0.0060)
Ln(Income per Capita)	0.6421	-0.0333	1.1007*	0.0223	0.3999	0.0688	0.5954	-0.0795
	(0.8311)	(0.1450)	(0.5752)	(0.0983)	(0.4889)	(0.0792)	(0.8047)	(0.2008)
House Price Index Divided by 1000	1.3028	0.0250	0.6406	-0.0175	0.3718	-0.0355	1.7482**	-0.0378
	(0.8583)	(0.1167)	(0.6411)	(0.0754)	(0.6468)	(0.0825)	(0.8538)	(0.1875)
State prime-age emp-to-pop ratio	0.5849**	0.0148	0.5450**	0.0150	0.3172*	0.0069	0.3801	0.0339
	(0.2497)	(0.0508)	(0.2461)	(0.0400)	(0.1771)	(0.0334)	(0.3024)	(0.0564)
Observations	96,095	96,095	189,075	189,075	409,121	409,121	52,065	52,065

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 more than $0.25 below the effective minimum wage in Columns 2, 4, 6, and 8. The sample is from the CPS MORG and consists of individuals ages 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 individuals ages 16–25, Columns 3 and 4 display estimates of the effect of minimum wage changes on average hourly wages and underpayment among individuals ages 16–35, Columns 5 and 6 display estimates of the effect of minimum wage changes on average hourly wages and underpayment among individuals ages 16–65, and Columns 7 and 8 display estimates of the effect of minimum wage changes on average hourly wages and underpayment among individuals ages 16–21. 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 census region by month-year fixed effects. All regressions include 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

Table A9. Relationship Between Minimum Wage Increases, Average Hourly Wage Increases, and Underpayment Among Individuals Ages 16–25, Ages 16–35, Ages 16–65, and Ages 16–21 Using Continuous Minimum Wage Variation Including Data from 2016–2019

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sample	Ages 16–25		Ages 16–35		Ages 16–65		Ages 16–21	
Dependent Variable	Hourly Wage	Underpayment	Hourly Wage	Underpayment	Hourly Wage	Underpayment	Hourly Wage	Underpayment
Effective Minimum Wage	0.1930***	0.0388***	0.1473***	0.0310***	0.1189***	0.0203***	0.3127***	0.0587***
	(0.0451)	(0.0067)	(0.0386)	(0.0045)	(0.0351)	(0.0032)	(0.0558)	(0.0096)
Ln(Income per Capita)	2.3285	-0.9952***	-0.1632	-0.3590	-0.1237	-0.3652	3.0914	-1.3939***
	(2.1101)	(0.3489)	(1.3629)	(0.2834)	(1.3361)	(0.2971)	(2.6296)	(0.4814)
House Price Index Divided by 1000	1.2542	0.5902**	0.7434	0.1331	0.7125	0.0148	-0.3082	0.5911*
	(1.6950)	(0.2206)	(1.3398)	(0.1700)	(1.3117)	(0.1589)	(1.8590)	(0.3312)
State prime-age emp-to-pop ratio	-0.0431	-0.0354	-0.0344	0.0032	-0.0634	0.0266	0.2625	-0.1649
	(0.4081)	(0.0994)	(0.3330)	(0.0811)	(0.2572)	(0.0696)	(0.5891)	(0.1317)
Observations	40,149	40,149	79,281	79,281	170,251	170,251	22,044	22,044

Notes: This table reports regression results examining the effect of minimum wage increases on average hourly wages and underpayment payment 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 more than $0.25 below the effective minimum wage in Columns 2, 4, 6, and 8. The sample is from the CPS MORG and consists of individuals ages 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 individuals ages 16–25, Columns 3 and 4 display estimates of the effect of minimum wage changes on average hourly wages and underpayment among individuals ages 16–35, Columns 5 and 6 display estimates of the effect of minimum wage changes on average hourly wages and underpayment among individuals ages 16–65, and Columns 7 and 8 display estimates of the effect of minimum wage changes on average hourly wages and underpayment among individuals ages 16–21. 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. All regressions include 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

Table A10. Relationship Between Minimum Wage Increases, Average Hourly Wage Increases, and Underpayment Among Individuals Ages 16–25, Ages 16–35, Ages 16–65, and Ages 16–21 Using Continuous Minimum Wage Variation, Including Data from 2016–2019, and Omitting Indexer States

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sample	Ages 16–25		Ages 16–35		Ages 16–65		Ages 16–21	
Dependent Variable	Hourly Wage	Underpayment	Hourly Wage	Underpayment	Hourly Wage	Underpayment	Hourly Wage	Underpayment
Effective Minimum Wage	0.3047***	0.0357***	0.1793***	0.0312***	0.1239***	0.0170***	0.4416***	0.0598***
	(0.0481)	(0.0087)	(0.0486)	(0.0064)	(0.0417)	(0.0061)	(0.0550)	(0.0148)
Ln(Income per Capita)	3.1118*	-0.5291	0.6752	-0.3380	0.5338	-0.3046	4.7762**	-0.9787*
	(1.6264)	(0.3561)	(1.3727)	(0.3207)	(1.2646)	(0.3235)	(1.9279)	(0.5723)
House Price Index Divided by 1000	3.9011***	0.2964	1.7339	0.0651	1.9250*	0.1477	3.7919**	0.2383
	(1.2318)	(0.1904)	(1.2308)	(0.1603)	(1.0502)	(0.1697)	(1.4526)	(0.2595)
State prime-age emp-to-pop ratio	-0.3158	0.0056	0.0690	0.0274	0.1484	0.0572	-0.2966	-0.0863
	(0.4926)	(0.1189)	(0.3802)	(0.0907)	(0.3020)	(0.0787)	(0.6544)	(0.1727)
Observations	32,790	32,790	64,558	64,558	138,118	138,118	18,013	18,013

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 more than $0.25 below the effective minimum wage in Columns 2, 4, 6, and 8. The sample is from the CPS MORG and consists of individuals ages 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 individuals ages 16–25, Columns 3 and 4 display estimates of the effect of minimum wage changes on average hourly wages and underpayment among individuals ages 16–35, Columns 5 and 6 display estimates of the effect of minimum wage changes on average hourly wages and underpayment among individuals ages 16–65, and Columns 7 and 8 display estimates of the effect of minimum wage changes on average hourly wages and underpayment among individuals ages 16–21. 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. All regressions include 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

Table A11. Relationship Between Minimum Wage Increases, Average Hourly Wage Increases, and Underpayment Among Individuals Ages 16–25, Ages 16–35, Ages 16–65, and Ages 16–21 Using Continuous Minimum Wage Variation, Including Data from 2016–2019, and Omitting States That Ever Had a Statutory Increase

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sample	Ages 16–25		Ages 16–35		Ages 16–65		Ages 16–21	
Dependent Variable	Hourly Wage	Underpayment	Hourly Wage	Underpayment	Hourly Wage	Underpayment	Hourly Wage	Underpayment
Effective Minimum Wage	0.2405**	0.0174	0.1712**	0.0125	0.0449	0.0010	0.4308***	0.0307*
	(0.1005)	(0.0117)	(0.0639)	(0.0080)	(0.0546)	(0.0087)	(0.0971)	(0.0175)
Ln(Income per Capita)	0.7943	-0.2685	-1.0903	-0.0534	-2.4925*	-0.2173	3.8191	0.2045
	(2.1082)	(0.4497)	(1.6505)	(0.4067)	(1.3566)	(0.4776)	(3.2075)	(0.4764)
House Price Index Divided by 1000	1.6582	0.4364	1.8900	0.2367	1.2714	0.1343	-0.6362	0.4744
	(1.9717)	(0.2644)	(1.2952)	(0.1999)	(0.9931)	(0.1897)	(2.9944)	(0.3325)
State prime-age emp-to-pop ratio	-0.2145	0.0844	-0.1711	0.1084	-0.2080	0.1017	0.1840	-0.0744
	(0.6085)	(0.1460)	(0.4396)	(0.1134)	(0.3675)	(0.1044)	(0.8523)	(0.1927)
Observations	23,665	23,665	45,722	45,722	97,411	97,411	13,073	13,073

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 more than $0.25 below the effective minimum wage in Columns 2, 4, 6, and 8. The sample is from the CPS MORG and consists of individuals ages 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 individuals ages 16–25, Columns 3 and 4 display estimates of the effect of minimum wage changes on average hourly wages and underpayment among individuals ages 16–35, Columns 5 and 6 display estimates of the effect of minimum wage changes on average hourly wages and underpayment among individuals ages 16–65, and Columns 7 and 8 display estimates of the effect of minimum wage changes on average hourly wages and underpayment among individuals ages 16–21. 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. All regressions include 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

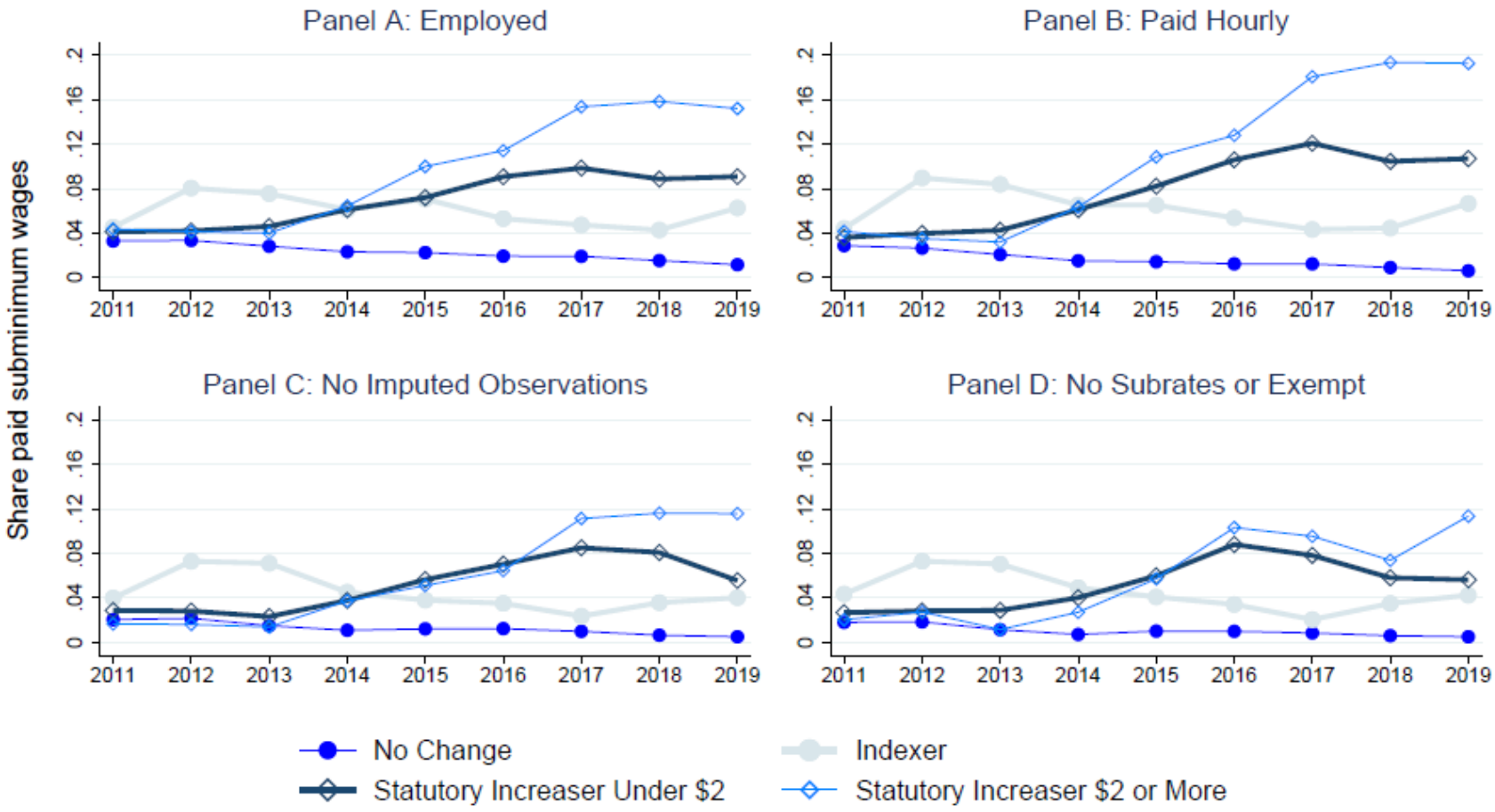

Figure A1. Incidence of Subminimum Wage Payment Across New Policy Categories Ages 16–25. This figure plots the share of individuals who reported hourly wages more than $0.25 below the effective minimum wage for each of our four policy groups, broken out across four subsamples, from 2011 to 2019. Data come from the Current Population Survey Merged Outgoing Rotation Groups (CPS MORG). Panel A includes all individuals ages 16–25 who are employed. Panel B restricts the sample to all individuals who are employed; paid by the hour; and do not receive overtime, tips, or commissions. Panel C restricts the sample to all individuals who are employed; paid by the hour; do not receive overtime, tips, or commissions; and whose wage rates are not imputed. Panel D restricts the sample to all individuals who are employed; paid by the hour; do not receive overtime, tips, or commissions; whose wage rates are not imputed; who do not live in states with local minimum wage rates; and who do not work in occupations exempt from the federal minimum wage. States are defined as statutory increasers under $2 if the combined statutory increase in their minimum wage between January 2013 and January 2017 was under $2. States are defined as statutory increasers of $2 or more if the combined statutory increase in their minimum wage was $2 or greater. Indexers are states that index their minimum wage to inflation. Averages are weighted by state population.

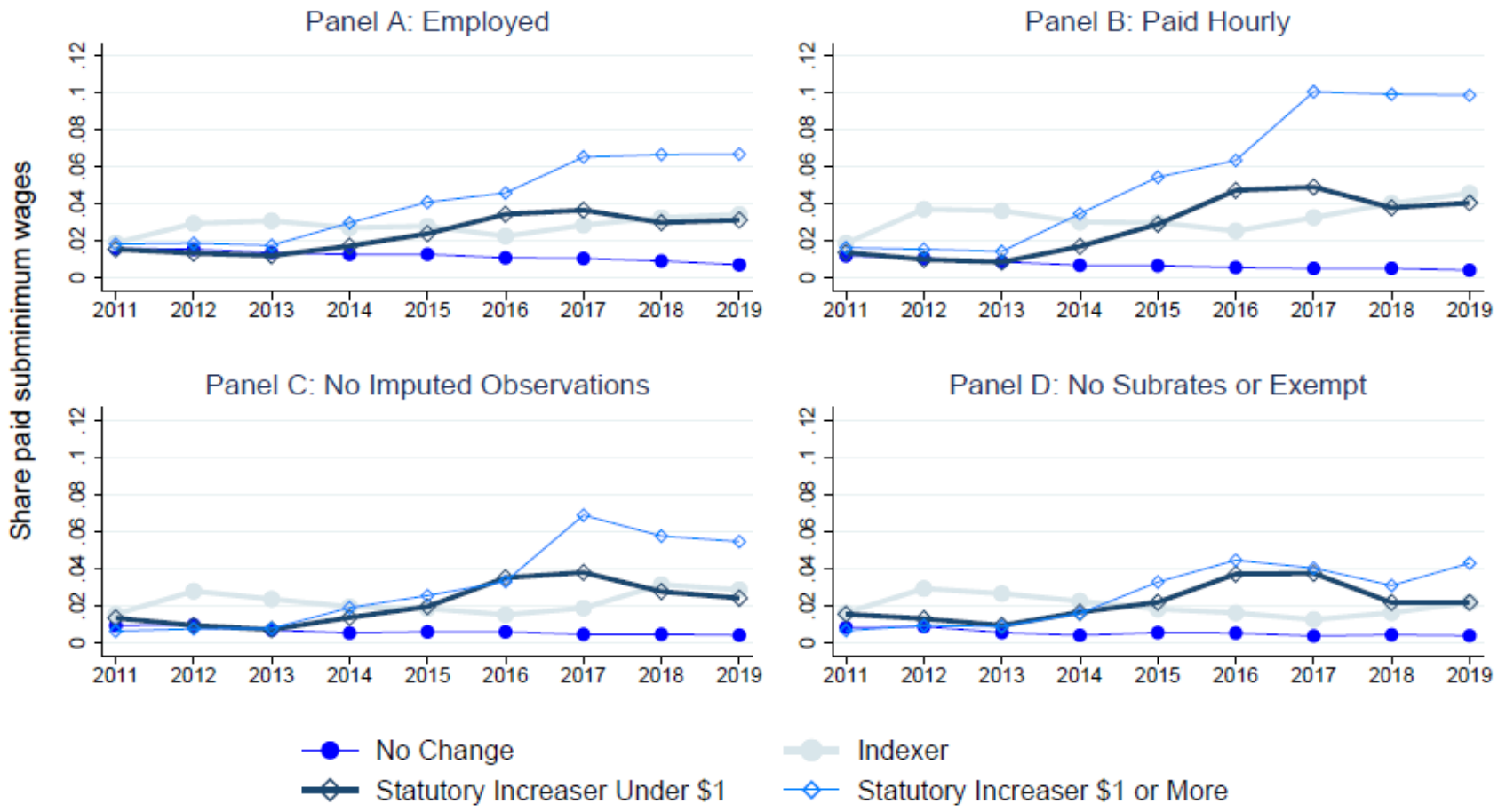

Figure A2. Incidence of Subminimum Wage Payment Across Original Policy Categories Ages 16–65. This figure plots the share of individuals who reported hourly wages more than $0.25 below the effective minimum wage for each of our four policy groups, broken out across four subsamples, from 2011 to 2019. Data come from the Current Population Survey Merged Outgoing Rotation Groups (CPS MORG). Panel A includes all individuals ages 16–65 who are employed. Panel B restricts the sample to all individuals who are employed; paid by the hour; and do not receive overtime, tips, or commissions. Panel C restricts the sample to all individuals who are employed; paid by the hour; do not receive overtime, tips, or commissions; and whose wage rates are not imputed. Panel D restricts the sample to all individuals who are employed; paid by the hour; do not receive overtime, tips, or commissions; whose wage rates are not imputed; who do not live in states with local minimum wage rates; and who do not work in occupations exempt from the federal minimum wage. States are defined as statutory increasers under $1 if the combined statutory increase in their minimum wage between January 2013 and January 2015 was under $1. States are defined as statutory increasers of $1 or more if the combined statutory increase in their minimum wage was $1 or greater. Indexers are states that index their minimum wage to inflation. Averages are weighted by state population.

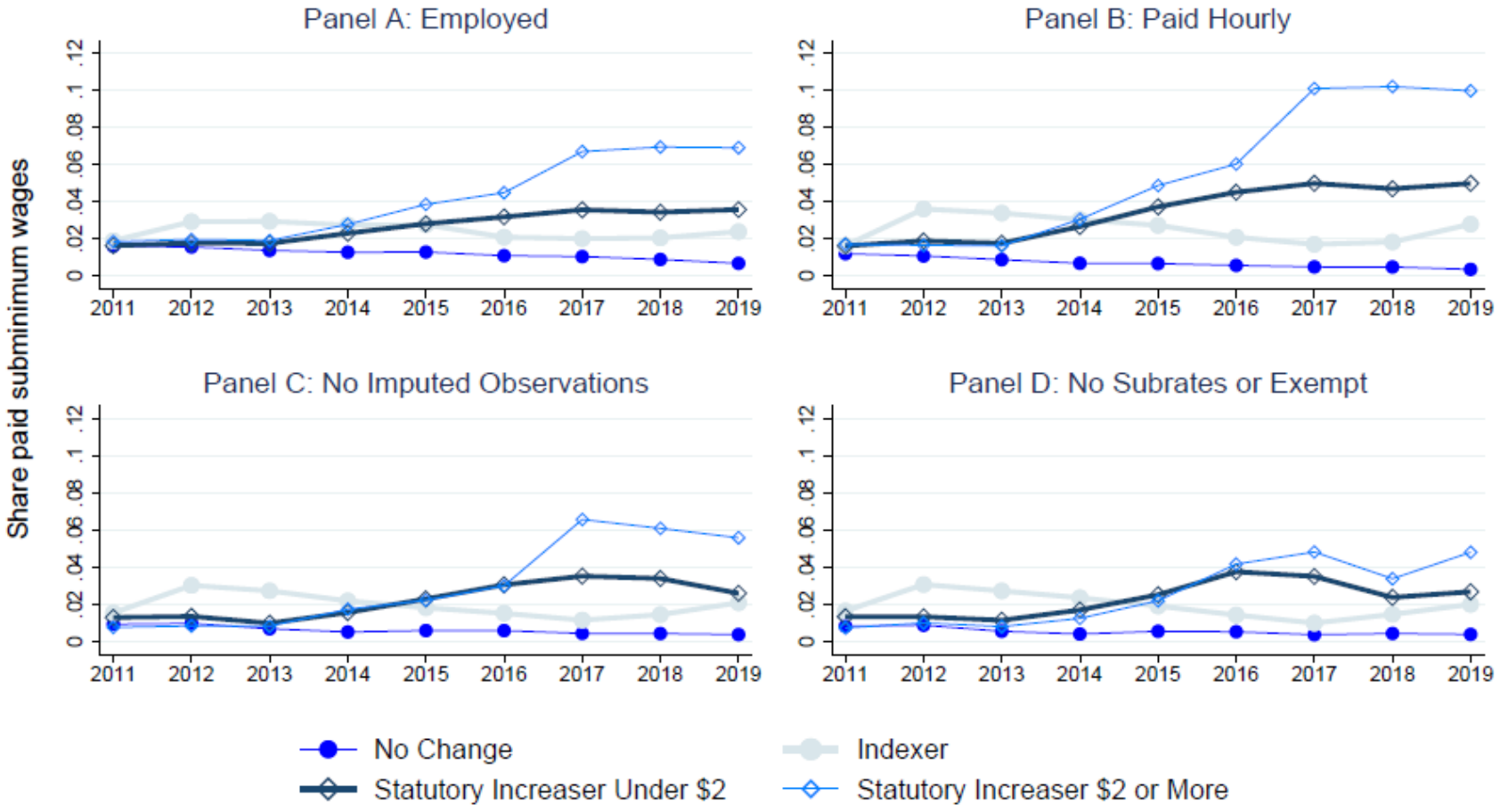

Figure A3. Incidence of Subminimum Wage Payment Across New Policy Categories Ages 16–65. This figure plots the share of individuals who reported hourly wages more than $0.25 below the effective minimum wage for each of our four policy groups, broken out across four subsamples, from 2011 to 2019. Data come from the Current Population Survey Merged Outgoing Rotation Groups (CPS MORG). Panel A includes all individuals ages 16–65 who are employed. Panel B restricts the sample to all individuals who are employed; paid by the hour; and do not receive overtime, tips, or commissions. Panel C restricts the sample to all individuals who are employed; paid by the hour; do not receive overtime, tips, or commissions; and whose wage rates are not imputed. Panel D restricts the sample to all individuals who are employed; paid by the hour; do not receive overtime, tips, or commissions; whose wage rates are not imputed; who do not live in states with local minimum wage rates; and who do not work in occupations exempt from the federal minimum wage. States are defined as statutory increasers under $2 if the combined statutory increase in their minimum wage between January 2013 and January 2017 was under $2. States are defined as statutory increasers of $2 or more if the combined statutory increase in their minimum wage was $2 or greater. Indexers are states that index their minimum wage to inflation. Averages are weighted by population.

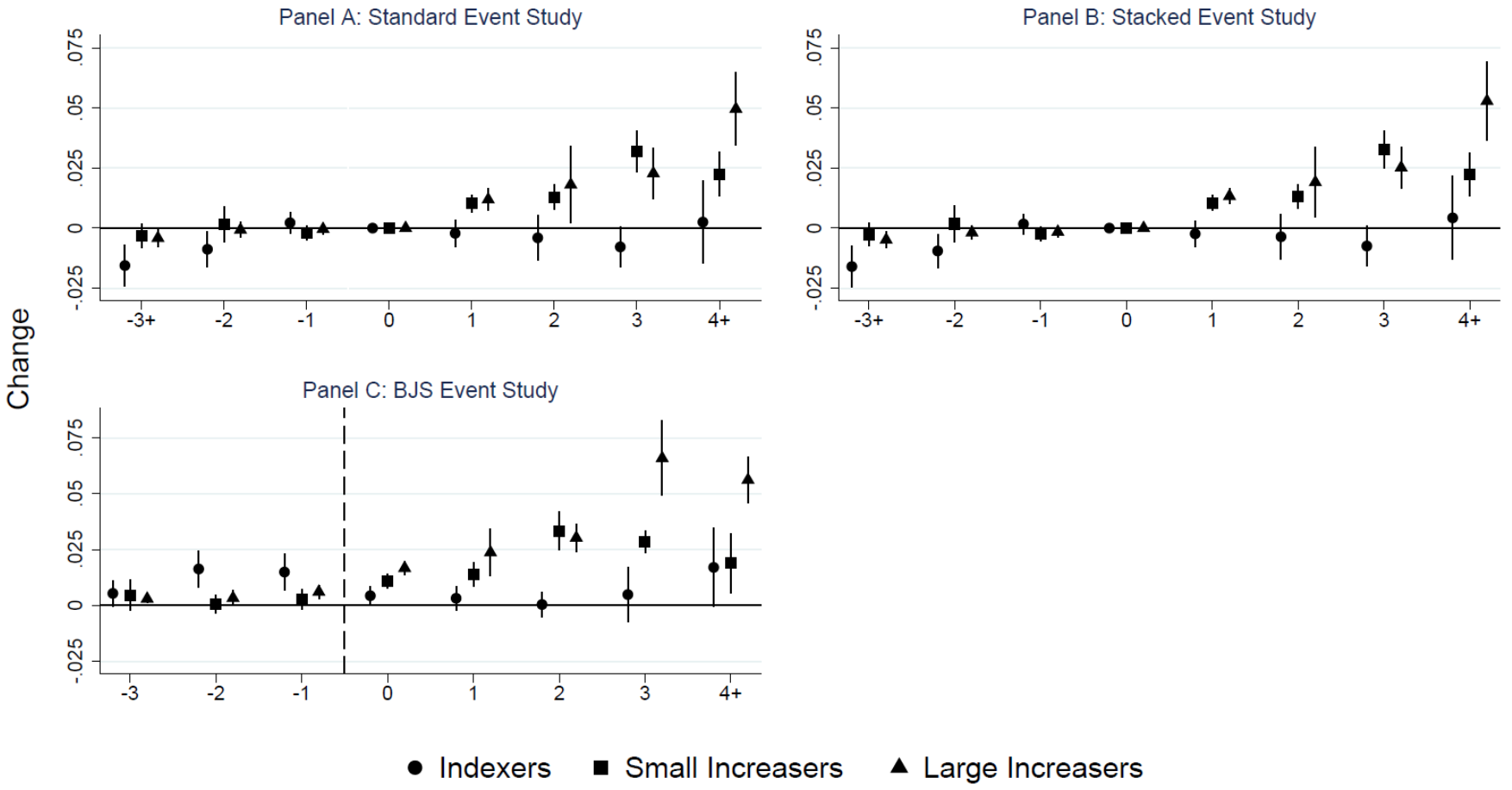

Figure A4. Event Studies of Changes in Subminimum Payment for Individuals Ages 16–65 Following Initial Minimum Wage Increases Using Various Event Study Estimators. This figure displays coefficients obtained from different event study estimators. Panel A displays results using the event study estimator in equation 2, Panel B displays results using the stacked event study estimator. Panel C displays results 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 are presented separately for minimum wage increases that were driven by inflation-indexing provisions ("indexer"), that involved "large" new statutory increases, and that involved "small" new statutory increases. 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 minimum wage increase occurred. The year of the initial increase is period 1 for the standard and stacked estimators in panels A and B, and period 0 for the BJS estimator in Panel C. For small and large increaser states, period 1 represents the year the first minimum wage increase took effect. For indexer states, period 1 corresponds to the year 2014. Error bars denote 95 percent confidence intervals around each estimated coefficient. Standard errors are clustered by state.

Figure A5. Distribution of Underpayment Across Policy Categories Ages 16–25. This figure plots the distribution of subminimum payment across each of our four state groups for the years 2011–2013 and 2016–2019. The samples are from the CPS MORG and consist of all individuals ages 16–25 who are employed; paid by the hour; do not receive overtime, tips, or commissions; and do not have imputed wage rates. The bins are $0.25 wide, and the height of each bin represents the share of each sample paid hourly wages from $6 to $0.01 less than the effective minimum wage.

Figure A6. Distribution of Underpayment Across Policy Categories Ages 16–65. This figure plots the distribution of subminimum payment across each of our four state groups for the years 2011–2013 and 2016–2019. The samples are from the CPS MORG and consist of all individuals ages 16–65 who are employed; paid by the hour; do not receive overtime, tips, or commissions; and do not have imputed wage rates. The bins are $0.25 wide, and the height of each bin represents the share of each sample paid hourly wages from $6 to $0.01 less than the effective minimum wage.

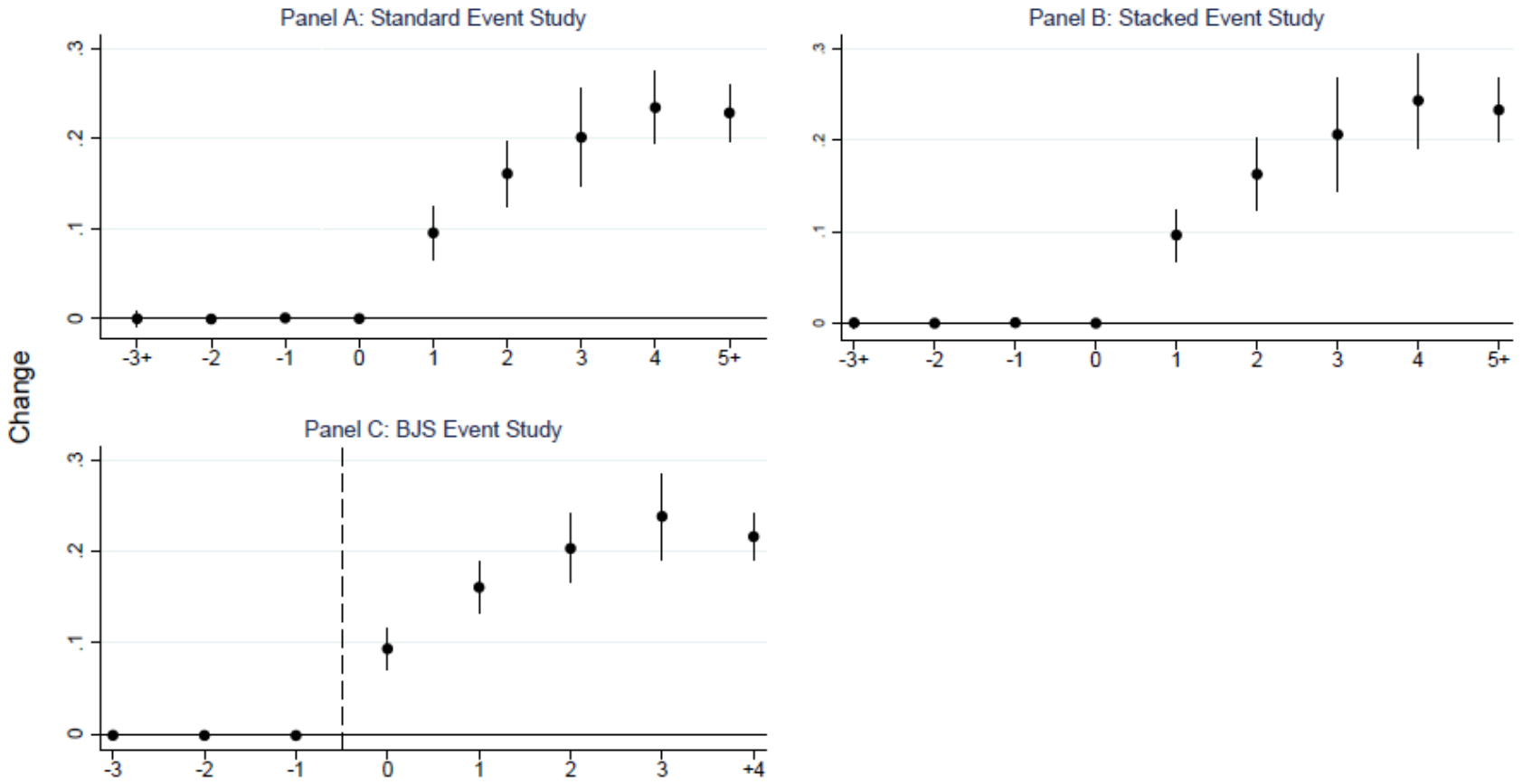

Figure A7. Event Studies of the Log Minimum Wage Following Initial Statutory Increases Only Including Years Where No Additional Increases Occurred. This figure plots event study coefficients following initial minimum wage increases for years where no additional increases occurred. The dependent variable is the log of the effective minimum wage. Panel A displays results using the event study estimator in equation 2, Panel B displays results using the stacked event study estimator. Panel C displays results using the imputation estimator proposed by Borusyak, Jaravel, and Spiess (2021) (BJS). For all panels, the sample consists of all individuals ages 16–25 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 5 years after a state's first minimum wage increase occurred. The year of the initial increase is period 1 for the standard and stacked estimators in panels A and B, and period 0 for the BJS estimator in Panel C. Error bars denote 95 percent confidence intervals around each estimated coefficient. Standard errors are clustered by state.

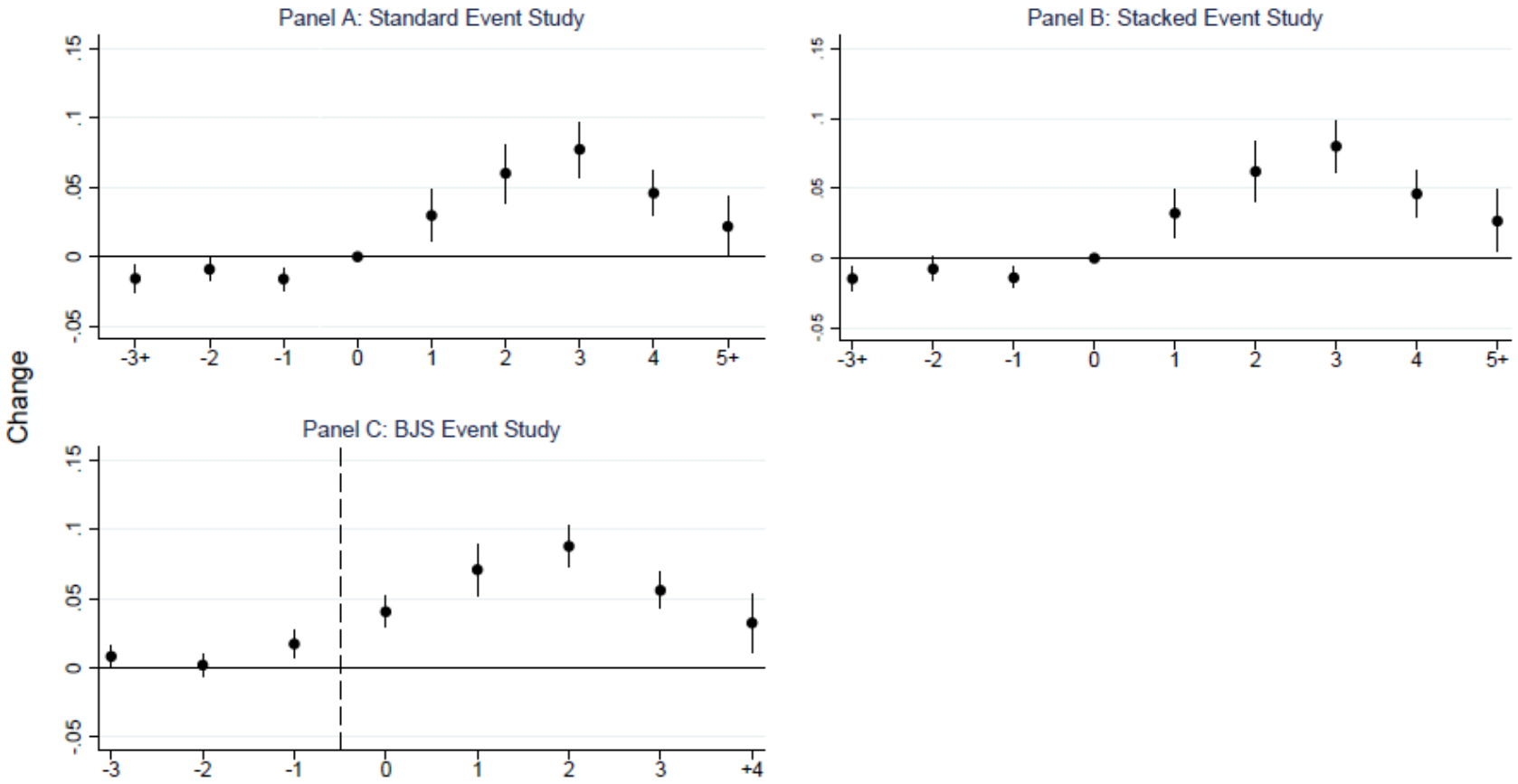

Figure A8. Event Studies of the Probability of Subminimum Wage Payment Following Initial Statutory Increases Only Including Years Where No Additional Increases Occurred. This figure plots event study coefficients following initial minimum wage increases for years where no additional increases occurred. Panel A displays results using the event study estimator in equation 2, Panel B displays results using the stacked event study estimator. Panel C displays results using the imputation estimator proposed by Borusyak, Jaravel, and Spiess (2021) (BJS). For all panels, the sample consists of all individuals ages 16–25 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 5 years after a state's first minimum wage increase occurred. The year of the initial increase is period 1 for the standard and stacked estimators in panels A and B, and period 0 for the BJS estimator in Panel C. Error bars denote 95 percent confidence intervals around each estimated coefficient. Standard errors are clustered by state.

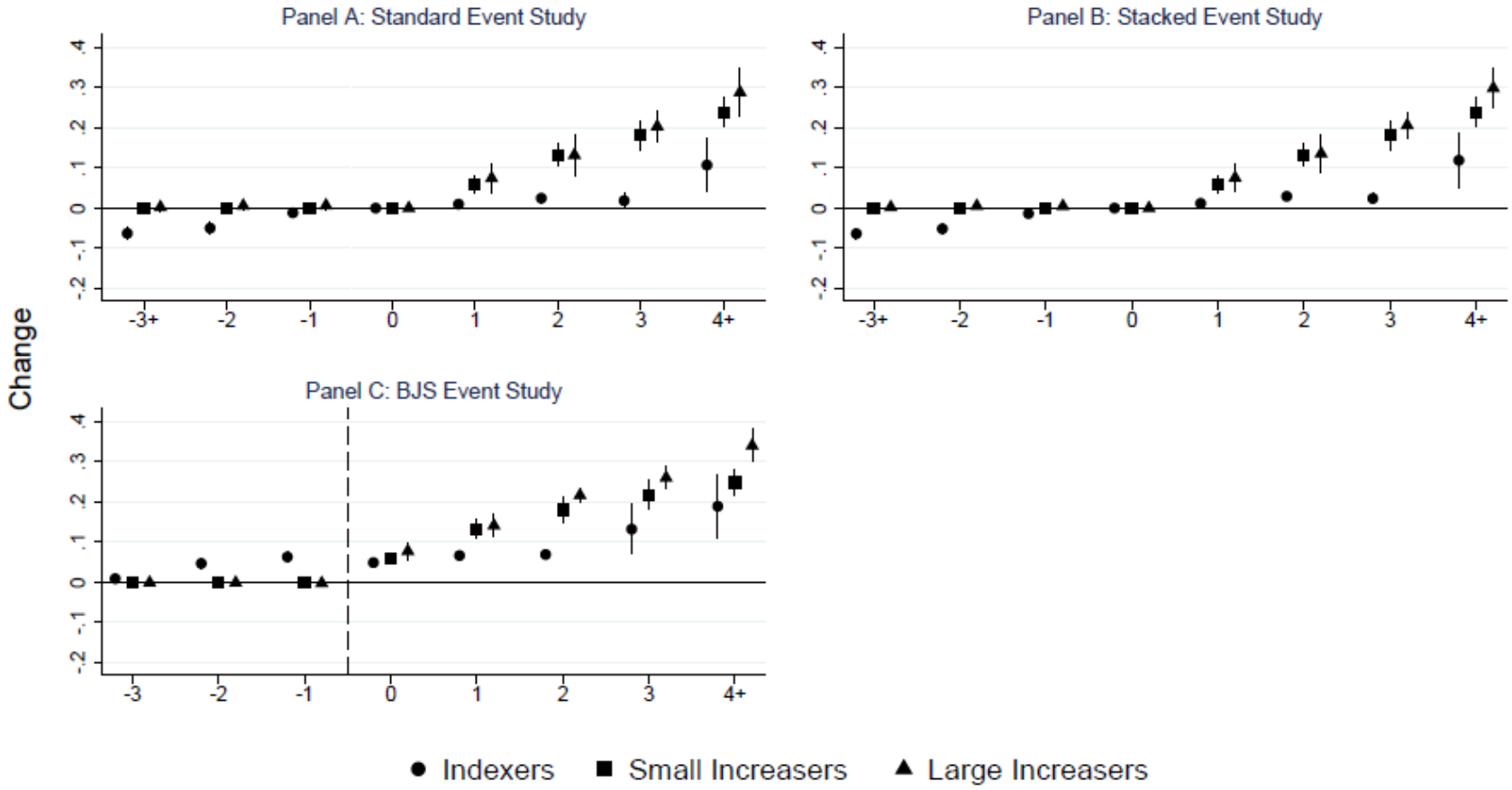

Figure A9. Event Studies of Changes in Log Minimum Wage Following Initial Minimum Wage Increases Using Various Event Study Estimators: This figure displays coefficients obtained from different event study estimators. Panel A displays results using the event study estimator in equation 2, Panel B displays results using the stacked event study estimator. Panel C displays results using the imputation estimator proposed by Borusyak, Jaravel, and Spiess (2021) (BJS). For all panels, the sample consists of all individuals ages 16–25 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 are presented separately for minimum wage increases that were driven by inflation-indexing provisions ("indexer"), that involved "large" new statutory increases, and that involved "small" new statutory increases. 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 minimum wage increase occurred. The year of the initial increase is period 1 for the standard and stacked estimators in panels A and B, and period 0 for the BJS estimator in Panel C. For small and large increaser states, period 1 represents the year the first minimum wage increase took effect. For indexer states, period 1 corresponds to the year 2014. Error bars denote 95 percent confidence intervals around each estimated coefficient. Standard errors are clustered by state.

Appendix B: Additional Analysis of Measurement Error

Measurement error is a crucial issue for our analysis to address. Our preferred estimates focus on samples of individuals ages 16 to 25 who are employed at hourly wage rates and whose wage rates are not imputed. This sample is less prone than others to the concern that wage rates recorded below the minimum wage are a result of measurement error rather than reflecting instances of true underpayment. Still, measurement error remains a potentially significant issue for our analysis. In this section we further probe the plausibility of the hypothesis that the relationship we observe between underpayment and increases in minimum wages is driven primarily by measurement error.

Appendix Table B1 presents evidence on whether the selection margins explored above were, themselves, responsive to this period's minimum wage changes. The table reports several findings of interest. First, neither indexed minimum wage increases nor small minimum wage increases had statistically significant relationships with employment, employment in tipped or otherwise exempt occupations, employment as hourly rather than salaried workers, nonresponse to the CPS's wage questions, or residence in states with substate, city-specific minimum wage rates. Second, large minimum wage changes have no detectable relationship with probabilities of employment in tipped occupations, imputed wage rates, residence in a state with substate minimum wage, or working in an occupation that is potentially exempt from the minimum wage. Third, employment of individuals ages 16 to 25 is negatively correlated with large minimum wage increases in the specification that controls for variations in states' macroeconomic conditions, but has no relationship with minimum wage changes in the specification that includes

no such controls. The same is true for estimates of the effect of large minimum wage changes on the probability of employment as an hourly-wage worker.

To be testable, the hypothesis that measurement error drives the relationship between minimum wage increases and underpayment must posit a specific form of measurement error. A leading candidate from the literature is measurement error of the form hypothesized by Autor, Manning, and Smith (2016) (hereafter, AMS) in their assessment of whether minimum wage spillovers can be distinguished from measurement error.

The AMS model of measurement error has two key components. First, it assumes that some fraction of the population correctly reports their wage rates while the remainder reports with error. Second, it assumes that the errors from those who misreport are normally distributed. It is straightforward to show that measurement error of this form can produce a combination of illusory underpayment as well as spillovers. Our simulations reveal, however, that the AMS model of measurement error is far from sufficient to explain the patterns of spillovers and underpayment that we observe in the data.

We begin our simulation of the wage data implied by the AMS model by estimating the mean and variance of the distribution of log wages across our primary analysis sample. Because this sample consists of relatively unskilled individuals, its mean is modest. The mean wage is just under $11.20, while the mean of the log wage is 2.36. The standard deviation of the log wage is 0.32.

The first step in simulating the AMS model is to generate a “true and latent” wage distribution using these parameters. The use of “true” in this simulation refers to the absence of measurement error, while the use of “latent” refers to the hypothetical absence of a minimum

wage. The model enables a test of the conjecture that measurement error of a particular form may be *sufficient* to explain patterns of spillovers and underpayment in the self-reported wage data. It does this by simulating how these data would look if the minimum wage generated neither spillovers, nor subminimum wage payment, nor declines in employment. The second step is to generate a "true" and "actual" distribution in which the minimum wage is introduced but measurement error is not. The third step is to inject measurement error based on the two key components mentioned above, namely a probability of reporting with error and a variance for the normally distributed error among those who report incorrectly.

We execute our simulation on a sample consisting of 100,000 observations for which we have generated a "true and latent" wage. To examine the effects of minimum wage changes under alternative assumptions regarding the measurement error parameters, we divide the simulated sample into 4 cells of equal size. These cells correspond with 2 "states" and 2 "time periods," where state 1 has a minimum wage of $8 in both time periods while state 2 has a minimum wage of $8 in period 1 and $9.50 in period 2. This is representative of the typical minimum wage change we analyze in our data.

We select the two parameters in the AMS model to match key moments in the data. The first moment in the data involves the mass of individuals who report working for wage rates at the minimum wage itself. As AMS emphasize, the effect of a minimum wage change on this mass can be used to infer the fraction of individuals who misreport their wage rates under the assumption that minimum wage increases result in neither positive spillovers nor true instances of underpayment. This is the sense in which the model is proposed as an alternative interpretation of the data. Second, the variance of the error among those who are assumed to

misreport their wage rates can be chosen to fit moments that relate to the dispersion in observed wages both above and below the minimum. We choose this parameter to match the mass we observe at wage rates that are either (a) between the minimum wage itself (non-inclusive) and $1 above the minimum wage, or (b) between the minimum wage itself (non-inclusive) and $1 below the minimum wage. Having selected the parameter in this way, we can then ask whether data simulated to match positive spillovers (the primary emphasis of AMS) also match the degree of underpayment. Similarly, we can ask whether data simulated to match underpayment also match the degree of positive spillovers. Three facts from this exercise provide evidence against the hypothesis that a pure measurement error model is sufficient to explain the underpayment we observe in the data.

First, for measurement error to be the primary driver of our results, the degree of misreporting in the CPS would have to be remarkably large. Consider the mass we observe at the minimum wage itself. In our analysis of CPS data, as shown in Column 1 of Appendix Table B2, we find that each dollar of increase in a state's minimum wage predicts a 3.7 percentage point increase in the fraction of employed individuals who are working at precisely the minimum wage. In our simulated data, the "true" fraction is 12 percentage points. For the AMS error model to match these moments, it must assume that only 31 percent of employed low-skilled individuals who are paid precisely the minimum wage on an hourly basis ultimately report the correct wage. While it is difficult to calibrate what does and does not constitute a reasonable degree of misreported minimum wage employment, the implied misreporting by 69 percent of the relevant individuals is quite high given the high salience of minimum wage rules.

Second, changes in the mass of wages that appear at exactly the minimum wage vary systematically across states. These variations are simultaneously consistent with real economic factors and inconsistent with a pure measurement error model. As shown in Appendix Table B2, we find a substantial divergence in the evolution of the mass of workers making exactly the minimum wage when we compare states that have recently enacted new minimum wage laws to states that have indexed their minimum wage rates to adjust predictably with inflation. We do this by running regressions in which we exclude one or the other group from the sample.

This divergence between states with indexed minimum wage changes and changes driven by new legislation is of interest for two reasons. First, inflation-indexed minimum wage changes and minimum wage increases linked to new legislation differ from one another economically (Brummund and Strain, 2020). The former have long been forecastable, meaning both firms and workers have had time to take their implications into account. For increases of this sort, the change in the mass of workers making the minimum wage is not dramatically different from what our simulations predict for the case in which a minimum wage increase has no spillover effects and results in no underpayment. Underpayment arises almost exclusively in response to newly legislated minimum wage changes, as we showed previously in Table 3 and through the time series presented in Figure 2. Models of measurement error provide no basis for expecting a divergence of this sort.

Second, it is well documented that survey respondents have a bias towards reporting round numbers (Schwabish, 2007; Gideon, Helppie-McFall, and Hsu 2017). Notably, new legislation has called for minimum wage rates that take round number values (e.g., $11), while inflation-indexed minimum wage changes often take irregular values (e.g., $8.56). An

interpretation of the data that relies on measurement error would thus predict the opposite of what we see when we compare inflation-indexed minimum wage increases to increases connected to recent legislation.

Finally, the combination of spillovers and underpayment that we observe in the data cannot be reconciled by a symmetric model of measurement error like that of Autor, Manning, and Smith (2016). In results we develop in Clemens and Strain (2022), we confirm Autor, Manning, and Smith's finding that patterns of spillovers and underpayment appear symmetric in analyses that include the entirety of the working age population. This symmetry is a compositional illusion, however, in that the positive spillovers accrue entirely to older workers while underpayment accrues almost entirely to the young. As shown in Clemens and Strain (2022), a symmetric model of measurement error thus struggles to explain patterns of spillovers and underpayment for either age group.

Table B1. Relationship Between Minimum Wage Increases and Worker Characteristics in the CPS MORG Using Minimum Wage Policy Categories

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Dependent Variable	Employed		Hourly		Not Imputed		No Subrates No Exempt		Self-Reported Wages	
Large Statutory Increaser x Post	-0.0021	-0.0329***	-0.0109	-0.0284***	-0.0093	-0.0156*	0.0013	-0.0022	0.0053	0.0052
	(0.0118)	(0.0099)	(0.0116)	(0.0088)	(0.0074)	(0.0083)	(0.0061)	(0.0049)	(0.0043)	(0.0050)
Small Statutory Increaser x Post	0.0006	-0.0002	0.0027	0.0034	-0.0103	-0.0110	0.0005	0.0002	-0.0035	-0.0028
	(0.0171)	(0.0097)	(0.0154)	(0.0098)	(0.0130)	(0.0111)	(0.0041)	(0.0037)	(0.0071)	(0.0050)
Indexer x Post	0.0104	0.0011	0.0041	-0.0007	0.0131	0.0149	0.0021	0.0021	-0.0014	-0.0004
	(0.0093)	(0.0068)	(0.0091)	(0.0093)	(0.0144)	(0.0120)	(0.0034)	(0.0029)	(0.0055)	(0.0052)
Ln(Income per Capita)		0.3846***		0.3440***		0.3359***		0.0091		-0.0946
		(0.0949)		(0.1074)		(0.0769)		(0.0345)		(0.0616)
House Price Index Divided by 1000		-0.0266		-0.0548		-0.1713***		-0.0161		0.0234
		(0.0645)		(0.0699)		(0.0512)		(0.0303)		(0.0349)
State prime-age emp-to-pop ratio		0.0998***		0.0620*		0.0726**		0.0084		-0.0188
		(0.0338)		(0.0356)		(0.0344)		(0.0132)		(0.0338)
Age and education controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Observations	329,455	329,455	329,455	329,455	329,455	329,455	329,455	329,455	329,455	329,455

Notes: This table reports regression results using different worker characteristics as dependent variables and using discrete categories to measure minimum wage changes. The sample is from the CPS MORG and consists of all individuals ages 16 to 25. Columns 1 and 2 report results with an indicator for whether an individual is employed, columns 3 and 4 report results with an indicator for whether an individual is paid by the hour, columns 5 and 6 report results with an indicator for whether an individual does not have imputed wage rates. Columns 7 and 8 report results with an indicator for whether an individual lives in a state with substate minimum wage rates or works in an occupation potentially exempt from the minimum wage. Columns 9 and 10 report results with an indicator for whether an individual has self-reported wages. 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. Age and education controls consist of a dummy variable for each education group and age. Standard errors are clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1

Table B2: Relationship Between Minimum Wage Increases and the Mass of Individuals Making Exactly the Minimum Wage in CPS Data As Compared with Data Simulated Using the Autor, Manning, and Smith Model of Measurement Error

	(1)	(2)	(3)
Sample	All States	Indexers	Statutory Increasers
Panel A: Regression Results on CPS Data			
Effective Minimum Wage	0.0373***	0.0773***	0.0278***
	(0.0106)	(0.0178)	(0.0068)
Observations	96,095	63,464	79,224
Panel B: Simulation Output			
Parameters chosen to match column 1	0.037	0.037	0.037

Notes: Panel A in the table reports regression results examining the effect of minimum wage increases on the probability that an individual reports making exactly the minimum wage. The sample in column 1 includes all states. The sample in column 2 excludes states that enacted minimum wage increases through new legislation, so that the estimate is driven entirely by inflation-indexing provisions. Column 3 excludes the states with inflation-indexing provisions so that the estimate is driven by states that enacted new statutory increases. All specifications include month, year, month-year, and state fixed effects. Standard errors are clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1. Panel B in the table reports the same moments of the data as Panel A, but for simulated rather than actual data.