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Prevailing Wage Repeal, Highway Construction Costs, and Bid Competition in Kentucky: A Difference-in-Differences and Fixed Effects Analysis

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Abstract

Data for over 2,000 highway pavement projects, constructed between 2014 and 2020, are used to examine the effect of Kentucky's prevailing wage repeal in 2017 on relative bid costs and bid competition for state and federally funded work. Other than Davis-Bacon and Disadvantaged Business Enterprise policies for federal projects, and prevailing wage requirements on state-funded work prior to 2017, all highway construction in Kentucky is built to the same standard. A difference-in-differences and fixed effects analysis fails to find statistically significant differences in bid costs and competition between federal and state projects before and after repeal. Competition on pavement projects in Kentucky is very low compared to other states. Consequently, the impact of increased competition on bid costs is very high. Policies increasing competition in Kentucky would be more effective in reducing costs than prevailing wage repeal.

Keywords

prevailing wage laws, construction costs, bid competition

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Prevailing wage laws establish minimum hourly wage and benefit rates for detailed job classifications by region. The main motivation for the policy is to prevent government funded projects from depressing local compensation standards (United States Department of Labor n.d, "Prevailing Wage Resource Book"). Relatively large public projects may attract contractors from areas where compensation rates are lower. This may motivate local contractors to reduce wage and benefit levels to remain competitive. The purpose of job and location-specific minimum compensation rates is to allow contractors to compete without pressure to reduce local standards. Prevailing wage requirements apply to construction funded by the federal government, 28 states, the District of Columbia, and municipalities such as the County and City of Denver.[1]

By protecting local wages, prevailing wage laws protect work for local contractors and their employees (Economic Policy Brief, 2011). Since prevailing wage rates are lower for apprentices, the policy contributes to the development of a skilled and safe workforce in a dangerous and unstable industry with few incentives to formally train workers (Philips, 2003). The majority of peer-reviewed research also indicates that the policy is not racially discriminatory (see Duncan and Ormiston, 2019 for a review). Despite the benefits of prevailing wage laws, the policy debate tends to focus on the impact of minimum compensation rates on the cost of public construction. Cost concerns were the chief motivation for the repeal of prevailing wage laws in six states between 2015 and 2018.[2] For example, the Legislative Research Commission (2016) calculated that since prevailing wages in Kentucky exceed alternative wage rates by an average of 25.7%, and labor costs average 30.7% of total school construction costs, the state's prevailing wage law increased the cost of public school construction by 7.9%, or 25.7% × 30.7%. Kentucky's construction wage policy was repealed in January of 2017 (Kentucky General Assembly, 2017).

This study is based on the statistical analysis of bid data for over 2000 highway pavement projects to exploit the natural experiment associated with the repeal of Kentucky's prevailing wage law. Specifically, the study uses an unbalanced panel of contractor bids to estimate a fixed effects difference-in-differences (DID) model to determine if the relative cost of state-funded asphalt projects changed with respect to the cost of comparable federal projects after repeal. A similar analysis examines the effect of repeal on the level of bid competition. The advantage of DID analysis is reduced concern over omitted variable bias with the use of pooled data. The additional benefit of a fixed effects estimate is the removal of bias associated with time-invariant unobserved contractor characteristics. This is the first study to combine DID and fixed effects in the examination of the prevailing wages on bid costs and bid competition.

Review of Literature on Prevailing Wage Laws and Construction Costs

Outside of the repeal of prevailing wage laws in numerous states in the 1980s and in the mid-2010s, along with the introduction of the policy in Colorado and Virginia in 2021,

this is not an area characterized by considerable policy change. Consequently, researchers typically rely on cross-sectional data to compare projects that are, and are not covered by prevailing wage laws. The usual statistical approach is to estimate contractor bid costs as a function of project characteristics including measures of size, location, bid date, as well as an identifier for projects covered by the wage policy. Due to the difficulty in obtaining information on change orders, follow-up maintenance, and add-on charges, only two studies have been able to measure the effect of the wage policy on final construction costs (Philips et al., 1995 and Bilginsoy, 1999).

To reduce the problem of unobserved heterogeneity associated with the use of cross-sectional data, researchers have focused on similar project types. Much of this research focuses on school construction costs because these projects are relatively common, costs related to education are of interest to the public, and because these projects are fairly uniform. Over time, the focus of this research has narrowed from national, to state, to county-level studies to reduce possible confounding effects of differences in other construction regulations and market conditions that may exist between jurisdictions. In spite of these differences, over 90 percent of these studies fail to find a statistically significant prevailing wage cost effect. See Duncan and Waddoups (2020) for recent example and detailed review of previous research on school construction. See Duncan and Ormiston (2019) for a comprehensive review of the research on prevailing wage laws.

While the examination of relatively homogenous school construction projects is one way to reduce omitted variable bias, challenges related to model specification remain for other studies. In the cross-sectional analysis of highway construction in Colorado, Duncan (2015b) finds that federal projects covered by the Davis-Bacon Act are larger and more complex than state-funded projects that were not covered by prevailing wage requirements. As a consequence, omitting measures of size and complexity contributes to a prevailing wage cost effect that is too high. When these measures are included, the cost differential between federal and state projects is no longer statistically significant. In the examination of affordable housing in California, Dunn et al. (2005) find that prevailing wage regulations increase building costs by as much as 37%. While this analysis includes information regarding the number and characteristics of housing units, measures of square-foot size are omitted. Littlehale's (2017) replication of Dunn, Quigley, and Rosenthal includes measures of project square foot size as well as a variable measuring project complexity, expenditures on architects and engineers. The prevailing wage cost effect from this analysis is between five and seven percent.

Four peer-reviewed studies examine the effect of the wage policy on highway construction costs. In a stochastic frontier regression analysis of 50 state departments of transportation, Vitaliano (2002) finds that the cost inefficiency of state-level prevailing wage laws adds eight percent to the annual cost of maintaining the nation's highway system. This analysis is based on department expenditures that include administrative costs such as prevailing wage determination and enforcement, in addition to any direct bid costs. States with prevailing wage laws tend to have higher population densities

(California and East Coast states) and may have other policies such as minority bidder representation requirements that may also be associated with increased expenditures. These factors are not included in the study by Vitaliano. Consequently, the inefficiency cost estimate may be too high.

Two studies compare the cost of asphalt resurfacing projects in Colorado that are funded by federal and state governments (Duncan 2015a, 2015b). At the time of these studies, Colorado did not have a state-level prevailing wage law. Federally funded highway projects adhere to Davis-Bacon prevailing wage and Disadvantaged Business Enterprise requirements. The latter program requires the U.S Department of Transportation to ensure that a minimum of 10% of the funds authorized for highway construction are expended on disadvantaged businesses (U.S. Department of Transportation, n.d.). The research on the cost effect of disadvantage business enterprise policies is neither as extensive, nor as conclusive as the research on prevailing wages. De Silva et al. (2012) find that federally funded highway resurfacing projects in Texas with high goals for disadvantaged business enterprise participation rates are no more costly than comparable projects with lower expectations. On the other hand, Marion (2009) reports that legislation prohibiting race and gender as considerations for state-funded construction was associated with a 5.6 percent decrease in bid costs. Regardless, results reported by Duncan (2015a, 2015b) indicate that contractor bids on federal projects do not differ from bids on state-funded work, nor do bids change when contractors switch from state to federal projects.

Manzo (2021) examines the effect of Iowa's federal-aid swap program on the cost of highway construction projects. Fifteen states have swapping programs that allow local governments to exchange their allocation of federal transportation funds for state monies. Projects that have been swapped are no longer covered by federal construction policies such as the Davis-Bacon Act or the Disadvantaged Business Enterprise Program. Results indicate that projects covered by federal regulations are no more expensive to build that those projects that are not covered by federal regulations. Results also indicate that federal projects are no more costly than projects that have been swapped.

Two studies use pooled cross-sectional data and DID analysis to examine the construction cost effect associated with the introduction of a minimum construction compensation standard in British Columbia in 1992. Duncan et al. (2014) and Duncan and Prus (2005) find that the preexisting cost difference between private and public building costs did not change with the introduction of minimum wages and benefits on projects funded by the province. Duncan (2015a, b) employs fixed effects models and cross-sectional data in the examination of highway resurfacing projects in Colorado. No study has combined DID and fixed effects in the analysis of panel data.

Review of Literature on Prevailing Wage Laws and Bid Competition

Prevailing wage opponents often claim that the policy contributes to increased construction costs by limiting bid competition. These assertions are frequently made

without empirical evidence (Leef, 2010). Five peer-reviewed studies have tested this hypothesis through the examination of cross-section bid data. Three studies examine school construction. Onsarigo et al. (2020) and Duncan and Waddoups (2020) fail to find statistically significant differences in the number of bidders between schools built with and without prevailing wages in Ohio and Nevada. Bilginsoy (1999) finds that the introduction of minimum construction compensation in British Columbia was associated with an increase in bid competition that diminished over time. Duncan (2015a) finds that the number of bidders on federal highway projects does not differ statistically from the level on comparable state-funded projects in Colorado. In the examination of various municipal construction projects in the Bay Area, Kim et al. (2012) report the same average number of bidders for projects in cities with prevailing wage laws as municipalities without the policy.

Kentucky's Prevailing Wage Law and Repeal

All specific information about Kentucky's prevailing wage law was deleted from Kentucky Labor Cabinet websites following repeal in 2017. Information described in this section was obtained from Manzo and Duncan (2016). Kentucky's prevailing wage law took effect in 1940, nine years after the Davis-Bacon Act was enacted. The policy was repealed on January 9, 2017. Prior to repeal, the payment of prevailing wage rates was required on public works projects with a cost of over $250,000. Public works included building, heavy, and highway construction funded by the state, school districts, or local governments.

Before repeal, the prevailing wage rate included the hourly base wage and fringe benefits for detailed job classifications, such as carpenters, electricians, plumbers, pipefitters, and operating engineers.[3] Prevailing wages rates were determined by one of two methods. The Kentucky Labor Cabinet conducted periodic hearings in 84 counties to collect data on the wages paid to construction workers within a locality, typically consisting of a single county or a group of counties. In the other 36 counties, federal Davis-Bacon rates were automatically adopted as the prevailing wage. Prevailing wage and benefit levels under the Davis-Bacon Act are determined through a survey conducted by the U.S. Department of Labor and apply to detailed job classifications in a county or a group of counties within a state (United States Department of Labor n.d. "Construction Surveys").

Regardless of differences between the two groups of counties, prevailing wage rates for state-funded projects in Kentucky were determined by a majority-average approach. If a majority of workers in a detailed job classifications and type of work (building, heavy, or highway) earned the same wage rate, that rate prevailed. If there was no majority wage, the weighted average rate for workers in the job classification prevailed. This is the same wage determination method used by the Davis-Bacon Act (USDOL Construction Surveys). According to information provided by personnel from the Kentucky Laborers-Employers Cooperation and Education Trust, representatives of the laborer's union submitted the same wage and hour rates used in

federal prevailing wage surveys to the 84 counties that relied on hearings to determine prevailing wage rates for state-funded projects. Representatives from the laborer's union indicated that the other trades involved in highway construction followed the same reporting practice. This would contribute to similarities between prevailing wage rates on state and federal projects within a locality.

While wage rates for state projects are subject to change after repeal, any change in compensation on federal projects after January 9, 2017 depends on applicable Davis-Bacon wage determinations (United States Deparment of Labor n.d.b. "Construction Surveys"). For example, union rates currently prevail for operating engineers and laborers in job classifications for asphalt work in the group of 44 counties that include Jefferson and other relatively urban counties (SAM.gov).[4] Prevailing wages for these workers in these counties will adjust with applicable collective bargaining agreements. On the other hand, prevailing wage rates for job classifications involving asphalt work in the group of 42 counties that include Lawrence and other more rural counties are based on average wage rates that have not changed since the 2015 wage determination.

Method, Data and Model

The statistical analysis utilizes a DID approach where projects financed exclusively by the Commonwealth of Kentucky represent the "treatment group" (that experienced the repeal of prevailing wage requirements). Projects receiving federal funds represent the "control group" of projects that were covered by federal Davis-Bacon prevailing wage requirements and were not affected by state-level repeal. Federal Disadvantaged Business Enterprise requirements also apply to transportation projects funded the federal government (USDOT, Disadvantaged Business Enterprise Program). Kentucky's Minority & Women Business Certification Program does not apply to construction procurement funded by the Kentucky Transportation Department (Commonwealth of Kentucky, n.d. "Minority & Women Business Certification Program). Other than Davis-Bacon and Disadvantaged Business Enterprise requirements, the Kentucky Transportation Cabinet has uniform construction standards for state or federal projects.[5] The DID framework determines if any pre-existing difference in bid cost or bid competition between state and federal asphalt projects was affected by the repeal of the state-level prevailing wage law.

This study is based on publicly available bid tabulations collected between 2014 and 2020 and covers three years of observations prior to repeal and almost 4 years after repeal (Kentucky Transportation Cabinet, n.d. "Unit Bid Tabulations"). The bid tabulations contain information on a variety of state and federally funded highway projects (asphalt resurfacing, bridge replacement and repair, and guardrail work, etc.) The tabulations contain project-level information on the names and bids of each competing contractor, as well as location, timing, and the length of the project (when applicable). Also included is the engineer's estimate that is the transportation cabinet's estimated cost of the project. Asphalt price indexes are available from other sources (Kentucky Transportation Cabinet, n.d. "Fuel and Asphalt Adjustments").

This study focuses on asphalt-related projects as these involve relatively similar types of work and are the most common form of highway construction in Kentucky. The treatment group consists entirely of state-funded "asphalt resurfacing" projects. This type of work principally involves the removal (milling) of several inches of existing road surface and the application of new asphalt material, followed by pavement marking and stripping. In addition, asphalt resurfacing projects may include limited amounts of electrical and guardrail work. The control group of federal projects typically involves asphalt milling and asphalt laydown, but also includes more work related to roadway rehabilitation, grade, and drain issues.[6] The use of pavement projects with different job descriptions for state and federal work is out of necessity. Between 2014 and 2020, almost all state asphalt projects involved asphalt resurfacing. Over the same period, very few federal projects were restricted to asphalt resurfacing. As a consequence, the control group of federal projects tends to be larger, more complex, and more expensive, on average, than the treatment group of state projects.

The sample of asphalt projects consists of 372 federal observations (114 before prevailing wage repeal and 258 after) and 1783 state projects (790 before and 993 after repeal). It is a characteristic of highway construction in Kentucky that a significant amount of asphalt work is completed by the same contractors. For example, three contractors account for low bids on about 39 percent of the 2155 projects included in the sample. Furthermore, only 13 contractors submitted a single low bid between 2014 and 2020. Deleting these 13 observations results in an unbalanced panel of contractors who placed low bids on at least two projects over the period of the study. Specifically, there are 51 contractor groups with the number of observations per group ranging from 2 to 309. About 65% of the contractors included in the sample submitted bids on state and federal projects between 2014 and 2020. The remaining contractors specialized in state or federal projects over this period. The unbalanced panel of 2155 bids is used to estimate the following fixed effects models estimating the low bid and the number of bidders.

Model 1

$$\text{Ln Nominal Low Bid}_{it} = \beta_0 + \beta_1 \text{ After Repeal}_{it} + \beta_2 \text{ State Project}_{it} + \beta_3 \text{ After Repeal x State Project}_{it} + \beta_4 \text{ Ln Engineer's Estimate}_{it} + \beta_5 \text{ Number of Bidders}_{it} + \beta_6 \text{ Rejected Bid}_{it} + \beta_7 \text{ Ln Asphalt Price Index}_{it} + \beta_8 \text{ Off-Peak Months}_{it} + \beta_9 \text{ District}_{it} + \beta_{10} \text{ Contractor}_{i} + \mu_{it}$$

Model 2

$$\text{Ln Number of Bidders}_{it} = \beta_0 + \beta_1 \text{ After Repeal}_{it} + \beta_2 \text{ State Project}_{it} + \beta_3 \text{ After Repeal x State Project}_{it} + \beta_4 \text{ Ln Engineer's Estimate}_{it} + \beta_5 \text{ Rejected Bid}_{it} + \beta_6 \text{ Ln Asphalt Price Index}_{it} + \beta_7 \text{ Off-Peak Months}_{it} + \beta_8 \text{ District}_{it} + \beta_9 \text{ Contractor}_{i} + \mu_{it}$$

In Model 1, *Ln Nominal Low Bid* is the natural log of the nominal lowest bid for a project submitted by contractor *i* in time period *t*. *After Repeal* is equal to one for

project bids that were submitted after January 9, 2017. Repeal of Kentucky's prevailing wage policy went into immediate effect on that date. *After Repeal* is equal to zero for project bids submitted prior to repeal. *State Project* is equal to one if the project received funding only from the Commonwealth of Kentucky and is equal to zero for projects receiving federal funds and covered by the Davis-Bacon Act and the Disadvantage Business Enterprise Program. *After Repeal x State Project* is the interaction of the *After Repeal and State Project* variables. The coefficient for this multiplicative term (β_3) measures the DID effect, or the change in the bid-cost differential between state and federal projects after repeal of the state-level policy. *Ln Engineer's Estimate* is the log of the transportation cabinet's estimated cost of the project taking into consideration current material, labor, and equipment costs, as well as overhead and profit (Kentucky Transportation Cabinet, 2010). The estimate is confidential and is not released until the date the Kentucky Transportation Cabinet opens bids. According to information provided by the transportation cabinet, the engineer's estimate is calculated through a combination of historical bid information, parametric estimate rates, and cost-based methodologies. Within the cost-based method, federal prevailing wage rates are used in the estimation of project labor costs for both state and federal projects. This is the practice before and after repeal. If the wage rates used in the cost estimate were to change with the repeal of the prevailing wage law, the engineer's estimate would capture some of the effect of the policy change. This would bias the results of the DID estimate. As is, the engineer's estimate measures the size and complexity of a project, without being influenced by repeal. *Number of Bidders* equals the number contractors who submitted a bid for each of the 2155 projects and measures the level of bid competition for each project. *Rejected Bid* is equal to one if the Kentucky Transportation Cabinet rejected a contractor's bid. This variable is equal to zero for projects that were awarded to the lowest bidder. Specifically, the Awards Committee of the Kentucky Transportation Cabinet determines if bids are to be awarded to the lowest bidder or if the bid is to be rejected (Kentucky Transportation Cabinet, 2010). This committee may reject bids for several reasons such as irregularities in project proposals submitted by contractors, bid collusion, or other cases where it is in the best interest of the Commonwealth to reject a bid. Ln *Asphalt Price Index* is the natural log of the average price of asphalt in the state (Kentucky Transportation Cabinet, Fuel and Asphalt Adjustments). This information is provided monthly and is matched to the corresponding month project information was made available to contractors. *Off-Peak Months* is equal to one during the months of January, February, March, October, November, and December. During these months, about 25% of projects are open for bidding. *District* is a vector of 12 highway districts used by the Kentucky Transportation Cabinet. District #5, home of Louisville, is the reference category. The $Contractor_i$ variable is a dummy variable identifying each contractor in the panel and is used in the explanation of the fixed effects model below. The error term is μ. In Model 2, the natural log of the number of bidders is regressed on the same independent variables used in Model 1, with the exception of the *Number of Bidders*. Model 2 is also estimated with the

Number of Bidders as the dependent variable. Results of this alternative estimate are reported in Appendix Table A (see Model 2C).

The specification of Model 1 illustrates how DID addresses omitted variable bias. The independent variables, including the *Ln Engineer's Estimate*, *Rejected Bids*, *Ln Asphalt Price Index*, *Off-Peak Months*, and *District* control for observable differences between and within the treatment and control groups. However, there may be differences between these two groups that are unobserved. The intent of the dummy variable (*After Repeal*) is to control for unobserved changes between the pre- and post-treatment period that affect the two groups equally. The purpose of the *State Project* dummy variable is to control for all unobserved differences between the treatment and control groups that do not change over time. With the independent variables controlling for the observable differences between treatment and control groups, and with the *State Project* and *After Repeal* variables controlling for unobserved effects, the average treatment effect (β_3) is measured with reduced concerns over omitted variable bias.

Model 1 can also be used to illustrate how a fixed effects estimate addresses omitted variable bias. As specified, Model 1 omits time-invariant measures of contractor characteristics that are related to bid costs such as innate abilities, management style that affects costs and labor productivity, rural or urban business location that determines access to supplies, business location in another state with different regulations that influence management behavior, and long-term commitment to collective bargaining agreements. Many of these same factors, as well as differences in innate contractor motivation to bid on projects may be relevant in the estimation of Model 2. Regardless of the model, the effect of these time-invariant characteristics is captured by the individual, or fixed effect variable $\text{Contractor}_{i.}$ in models 1 and 2. While there are several approaches to removing the effect of the time-invariant characteristics from the estimate, the approach used here is based on 'demeaned' dependent and independent variables. With the combined DID and fixed effects approaches, the average treatment effect (β_3) is measured with reduced concern over omitted variable bias with the *After Repeal* and *State Project* variables controlling for unobserved differences overtime, as well as between and within the treatment and control groups, while the fixed effect estimates controls for unobserved contractor characteristics.

Results

Summary statistics for the main project characteristics of interest are reported in Table 1. Kentucky's prevailing wage law applied to projects with a cost of more than $250,000. As a consequence, the treatment and control groups consist of projects with low bids in excess of $250,000. Data indicate that the average low bid and the engineer's estimate for federal projects are substantially larger than the corresponding average for state-funded asphalt resurfacing work. The average low bid for federal work is approximately $3.7 million compared to roughly $660,000 for the typical state asphalt resurfacing project. The relatively larger engineer's estimate for federal work

Table 1. Selected Summary Statistics for Kentucky Transportation Cabinet Highway Asphalt Projects, 2014–2020.

Variable	Average for Federal Projects	Average for State Projects
Low bid	$3,704,278[a] (6,711,818)	$658,290.8 (479,423.7)
Engineer's estimate	$3,802,832[a] (6,627,037)	$678,941.7 (474,397.6)
Number of bidders	1.88[a] (1.15)	1.56 (0.91)
N =	372 combined	1,783 combined

Source: Unit Bid Tabulations, Kentucky Transportation Department. Projects with Low Bids great than $250,000 included. Standard deviations in parentheses.
[a]The mean for federal projects is different at the 0.05 level from the comparable mean for state projects.

($3.8 million) indicates that these projects are larger and more complex than state projects with an average cost estimate of about $680,000. In both cases, the average engineer's estimate is larger than the average low bid. The differences in low bids and engineer's estimates between federal and state projects are statistically significant at the 0.05 level. The ratio of the average low bid to the average project cost estimate is 0.974 ($3,704,278 / $3,802,832) for federal projects and 0.970 ($658,290.8 / $678,941.7) for state projects. Adjusted for estimated costs, average bids on federal and state projects are similar.

On average, federal projects have 1.88 bidders per project. The average level of bid competition on state-funded projects is 1.56 bidders. The difference in the number of bidders between federal and state projects are statistically significant at the 0.05 level. The overall average number of bidders per project across the state, before and after repeal, is 1.62. Approximately 61% of these pavement projects involved one bidder, about 23% of projects had 2 bidders, and 0.09% included the highest level of 8 bidders (see Appendix Figure A for the complete distribution of bids). Compared to pavement projects in other states, the average level of bid competition for paving projects in Kentucky is low. Duncan's (2015a) examination of resurfacing projects between 2000 and 2011 in Colorado indicates an average of 4.3 bidders on federal projects and 3.3 competitors on state-funded work. In the examination of pavement projects in Texas between 1997 and 2000, De Silva et al. (2012) report an average of 3.8 bidders on projects without federal disadvantage business enterprise goals and 3.9 bidders on projects with minority business participation goals. All of these averages exceed the statewide average level of bid competition in Kentucky by more than a factor of two.

Regression results for the fixed effects estimates are reported in Table 2.[7] The results of primary interest are the coefficients for the interaction terms *After Repeal* x *State Project* for models 1 and 2. The results for these models indicate that there is no statistically significant change in relative bid cost or bid competition between state and federal projects after repeal of Kentucky's prevailing wage law. This is the case at conventional levels of statistical significance for one or two-tailed tests. These basic findings do not change when different samples or model specifications are employed. Results from alternative estimates are reported in Appendix Table A and indicate that the findings with respect to the DID

Table 2. Fixed Effects Regression Results for the Nominal Low Bid and the Number of Bidders for Kentucky Transportation Cabinet Highway Asphalt Projects, 2014–2020. Dependent Variable = Log of Low Bid (Model 1), Log of Number of Bidders (Model 2).

Variable	Model 1	Model 2
After repeal	0.031[a] (0.017)	–0.001 (0.078)
State project	0.0005 (0.012)	–0.064 (0.066)
After Repeal x State Project	–0.020 (0.018)	0.017 (0.080)
Log of engineer's estimate	0.997[c] (0.004)	0.011 (0.019)
Number of bidders	– 0.059[c] (0.005)	—
Rejected Bid	0.113[c] (0.009)	–0.180[c] (0.048)
Log of Asphalt price index	0.025[c] (0.009)	–0.062 (0.079)
Off-peak months	–0.009[a] (0.005)	0.051[c] (0.015)
District 1	–0.039 (0.031)	–0.766[c] (0.235)
District 2	– 0.040[d] (0.025)	–0.590[b] (0.230)
District 3	–0.044[a] (.022)	–0.504[b] (0.233)
District 4	–0.032[d] (0.021)	–0.489[b] (0.230)
District 6	–0.031[b] (0.015)	–0.059 (0.164)
District 7	–0.053[a] (0.028)	–0.493[b] (0.233)
District 8	–0.031 (0.026)	–0.511[b] (0.220)
District 9	–0.046[a] (0.025)	–0.276[d] (0.210)
District 10	–0.039[d] (0.024)	–0.483[b] (0.196)
District 11	–0.028 (0.023)	–0.471[b] (0.216)
District 12	–0.030 (0.024)	–0.403[a] (0.207)
Constant	0.041 (0.062)	1.070 (0.416)
N =	2,155	2,155
F=	10,992.6	13.80
R^2 (overall) =	0.988	0.251

Source: Unit Bid Tabulations, Kentucky Transportation Cabinet. Standard errors in parentheses are corrected for heteroskedasticity.
[a]significant at the 0.10 level;
[b]significant at the 0.05 level;
[c]significant at the 0.01 level (two-tailed tests).
[d]significant at the 0.10 level;
[e]significant at the 0.05 level (one-tailed test).

analysis of bid cost and bid competition are unchanged when the sample is based only on awarded projects (see models 1A and 2A). The same applies when the observations extending over the period of the Covid-19 pandemic (February to December 2020) are omitted (see models 1B and 2B). Additionally, the results do change when the *Ln Engineer's Estimate* is omitted from Model 1 or when Model 2 is based on the *# of Bidders* instead of the *Ln # of Bidders* (see Model 1C and Model 2C).

The DID results described above are from the perspective of the partial derivative for Model 1 of the change in Ln Nominal Bid with respect to a change *State Project*. Similarly, for Model 2 the partial derivative is the change in *Ln Number of Bidders* with

respect to a change in *State Project*. The other side of the partial derivative provides information regarding differences in bid costs and bid competition between federal projects, that are covered by the Davis-Bacon Act and the Disadvantage Business Enterprise Program, and state projects that are not covered by prevailing wage regulations after repeal. In this case, the applicable partial derivative for Model 1 is the change in Ln Nominal Bid with respect to a change in *After Repeal*. For Model 2, the partial derivative is the change in *Ln Number of Bidders* with respect to *After Repeal*. Results of the coefficients for the interaction terms for both models indicate that after repeal, bids on state-funded projects are not significantly different from bids on federal projects. Also, there is no statistically significant difference in the level of bid competition between federal projects and state-funded projects that are not covered by prevailing wage laws.

Other results reported in Table 2 for Model 1 indicate that, after repeal, bids on all projects were three percent higher. This difference is statistically significant at the 0.10 level for a two-tailed test. The results of the interaction term and the *After Repeal* variable illustrate the short-comings of a simple before-and-after test of the effect of prevailing wage repeal on state-funded projects. When the sample is restricted to 1770 state-funded highway resurfacing projects, and the *State Project* and *After Repeal x State Project* variables omitted, results for *After Repeal* indicate that bid costs on these projects increased by 1.8% (see Appendix Table A, Model 1D). This coefficient is significant at the 0.01 level. On the other hand, the DID model is able to separate the change in bids over time from the effect of repeal.

In spite of the substantial and statistically significant average bid cost difference between federal and state-funded projects reported in Table 1, the bid cost difference between federal and state projects (measured by *State Project* for Model 1) is not statistically significant, taking the engineer's estimate into consideration. As described above, state projects included in the sample are exclusively asphalt resurfacing projects. Federal projects consist of a variety of pavement project descriptions that involve tasks other than asphalt resurfacing. One method of taking differences in work type into consideration involves the use of dummy variables by pavement work type. This is not an option in this case because work type dummy variables only apply to federal projects. The result reported above regarding the statistically insignificant coefficient for the *State Project* variable indicates that additional measures of work type are not needed to control for differences between state and federal projects. Differences between state and federal projects are completely controlled for by the *Ln Engineer's Estimate*. In other words, if federal projects involve work types that are more expensive than state asphalt resurfacing projects, this difference is principally captured by differences in the engineer's estimates between the two types of projects. Results reported in Model 1C of Appendix Table A illustrate the effect of the *Ln Engineer's Estimate* on the coefficient for *State Project* as well as the overall estimate. When *Ln Engineer's Estimate* is omitted from the estimate, the coefficient for *State Project* is – 1.321 (with a standard error of 0.122). This effect is statistically significant at the 0.01 level. The R^2

for the estimate is 0.988 when *Ln Engineer's Estimate* is included and 0.304 when this variable is omitted.

The coefficient for the *Ln Engineer's Estimate* indicates that a one percent change in the estimate is associated with a 0.997 percent change in the low bid. Other studies examining highway bids report similar results regarding the engineer's estimate (Duncan 2015a, 2015b, De Silva et al., 2003 and De Silva et al., 2012). One more bidder is associated with an approximate six percent decrease in project bid cost. This large reduction in bids associated with another bidder is likely related to approximately 61% of projects with only one participating contractor. Bids that have been rejected are approximately 11% higher than awarded bids. Bids are roughly three-hundredths of one percent higher when average asphalt prices increase by one percent. This indicates that asphalt prices have an impact independent of the cost of this material that is included in the engineer's estimate.[8] The coefficients for the engineer's estimate, number of bidders, rejected bids, and the asphalt price index are statistically significant at the 0.01 level for a two-tailed test. Bids are lower during the 6 months book-ending the end and beginning of the calendar year. This effect of *Off-Peak Months* is statistically significant at the 0.10 level for a two-tailed test. Bids differ at various levels of statistical significance for districts 2, 3, 4, 6, 7, 9 and 10, relative to District 5. The overall R^2 for the fixed effects estimate of the low bid is very high and consistent with other studies that include the engineer's estimate in the examination of highway bid costs (Duncan 2015a, 2015b, De Silva, Dunne and Kosmopolou, 2003 and De Silva, Dunne, Kosmopoulou, and Lamarche, 2012).

Results for Model 2 indicate that there is no statistically significant effect on the *Ln Number of Bidders* of *After Repeal*, *State Project*, *Ln Engineer's Estimate*, or *Ln Asphalt Price Index*. Projects with rejected bids have about 18% fewer bidders than projects with bids that were accepted. This effect is statistically significant that the 0.01 level for a two-tailed test. During the *Off-Peak Months* of reduced project availability, the number of bidders per project is about five percent higher. The effect of *Off-Peak Months* is statistically significant at the 0.01 level for a two-tailed test. All districts, excepting District 6 have less bid competition than District 5. These differences are statistically significant at various levels for one and two-tailed tests.

Results regarding the effect of the repeal of prevailing wages in Kentucky on bid costs and bid competition are consistent with Duncan's (2015a) examination of highway resurfacing construction in Colorado. This author finds no statistically significant difference in low bids or bid competition between projects funded by the State of Colorado, that were not covered by a prevailing wage standard, and federal-funded projects, that were covered by the Davis-Bacon Act and the Disadvantage Business Enterprise Program.

One reason prevailing wage regulations do not affect highway construction costs is that labor costs are a low percent of total construction costs in this sector. For example, data from the 2017 *Economic Census of Construction* indicate that blue collar construction worker labor costs (wages and benefits), for contractors involved in highway, street, and bridge construction in the Bluegrass State, are 21% of the net value

construction. The net value of construction is the value of contractor construction, less the value of work subcontracted out (U.S. Census Bureau, 2017). When all building types are considered, labor costs represent 23% of the net value of contractor construction in Kentucky and across the United States. Additionally, peer-reviewed research indicates that when wages increase in the construction industry, contractors respond by utilizing more capital equipment and substituting skilled workers for less-productive counterparts (Balistreri, McDaniel and Wong, 2003 and Blankenau and Cassou, 2011). Since labor costs represent a small portion of overall costs, relatively minor changes in labor utilization and productivity are needed to offset the effect of the wage policy.

The parallel trends assumption of DID analysis requires that the outcome variable for the treatment group exhibit the same pattern as that of the control group in the period prior to the treatment. Trends in the outcome variable between the two groups that are not parallel suggest the influence of an omitted long-run trend that undermines the measurement of the effect of the treatment. Parallel trends in yearly average low bids (adjusted for the engineer's estimate) and the number of bidders for the two groups are presented below. Placebo DID regressions are also used to provide evidence of parallel trends.

Figure 1 reports average ratios of low bids to the engineer's estimate for federal and state projects for each year of the study. These trend lines show that during the pre-

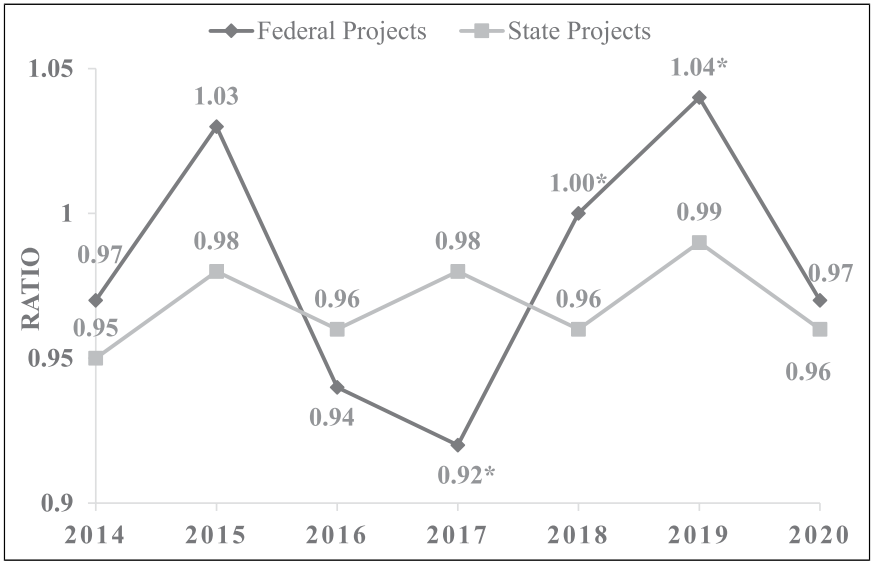

Figure 1. Test of Parallel Trends: Yearly Average Ratio of the Low Bid to the Engineer's Estimate. Federal and State Projects, 2014 to 2020. Source: Unit Bid Tabulations, Kentucky Transportation Department. Projects with Low Bids great than $250,000 included. *the mean for federal projects is different at the 0.05 level from the comparable mean for state projects.

treatment period, the numeric values of the ratios vary over time and between federal and state projects. While the paths are not parallel, the differences between federal and state average ratios are not statistically different at the 0.5 level in each year prior to the treatment. In terms of statistical significance, this suggests a common trend in the outcome variable between the two groups. Beginning in 2017, statistically significant differences are present. The ratio is larger for state projects in the first year of the treatment (2017) with relative cost increases for federal projects in 2018 and 2019. The trends in the ratios reported in Figure 1 are roughly consistent with a treatment effect that increased the relative costs of federal projects after repeal. However, the ratios are also influenced by changes in transportation funding.

While the Kentucky Transportation Cabinet has a six-year transportation plan, the annual budget allocation process accommodates regional transportation needs and other priorities (Kentucky Transportation Cabinet, 2020b). In addition, funding and construction priorities for the Kentucky Transportation Cabinet change over time. For instance, in the 2014–2015 fiscal year, federal funds represented 28% of the total budgeted funding (Kentucky Transportation Cabinet, Budget and Fiscal Management). By the 2019–2020 fiscal year, this percentage increased to 33 percent. The trend in the ratios in the post-treatment period illustrates the effect of changes in funding priorities on federal projects. In 2017, the average low bid on federal projects dropped to $2.8 million, down from the pre-treatment yearly average of $4.7 million. This drop in low bids exceeded the decrease in the average engineer's estimate for this year, so the ratio decreased in this period. Average low bids for federal projects in 2018 and 2019 rebounded to $3.7 million and $4.7 million, with these averages rising faster than engineer's estimates. Yearly average low bids for state projects remained close to the overall average of $639,000, with exceptions in 2019 ($766,000) and 2020 ($506,000). These data suggest that changes in the ratios for federal projects in 2017, 2018, and 2019 reflect shifts in funding priorities rather the effect of the treatment. Since these changes may have occurred in any year, it is mere coincidence that the trend is common before repeal. Given this additional information, the usual comparison of the outcome variable before the treatment effect may not be useful in this case.

The same applies to the outcome variable for Model 2. Figure 2 includes trend lines for the yearly average number of bidders for federal and state projects. The average number of bidders on federal projects is 1.92, 1.97, and 1.8 for each year prior to the treatment. The yearly averages for 2014 to 2016 for state projects are 1.61, 1.43, and 1.68 bidders. The difference in the number of bidders is statistically larger for federal projects in 2015. These data do not indicate parallel trends before the treatment. Average bid competition is statistically larger for federal projects in the year of the treatment. The absence of statistically significant differences in the average number of bidders in the post-treatment period suggests a parallel trend. Results reported in Table 2 indicate that the number of bidders varies with the *Off-Peak Months* and between districts. The average annual trend does not take these factors into consideration.

Placebo regressions offer a more formal method of examining the parallel trends assumption by falsely applying the "treatment effect" to the pre-treatment period. The

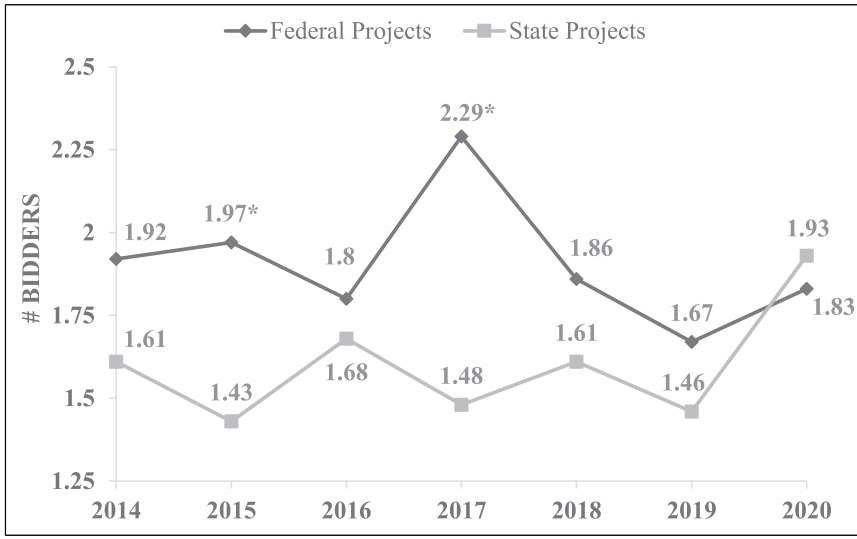

Figure 2. Test of Parallel Trends: Yearly Average Number of Bidders. Federal and State Projects, 2014 to 2020. Source: Unit Bid Tabulations, Kentucky Transportation Department. Projects with Low Bids great than $250,000 included. *the mean for federal projects is different at the 0.05 level from the comparable mean for state projects.

placebo regression approach has an advantage over the data reported in Figures 1 and 2 due to controls for factors such as project size and complexity, location, and *Off-Peak Months* that may change over time and affect relative trends. Fredriksson and Magalhaes de Oliveira (2019) describe several placebo methods that involve changing the "treatment" to each year of the pre-treatment period or assigning the treatment to one year when only the pre-treatment data are used. Results of each of these tests, applied to the Kentucky highway project data are reported in Table 3. For space considerations, results are reported only for the coefficients of interest (for the *After Repeal*, *State Project*, and *After Repeal x State Project* variables).

Results for models 1A and 2A are based on data for the pre-treatment period (2014–2016) with the treatment falsely assigned to 2015. This placebo model compares the false treatment period of 2015 and 2016 to the pre-treatment period of 2014. The coefficients for the interaction term (*After Repeal x State Project*) for the estimates of the *Ln Nominal Low Bid* (Model 1A) and the *Ln Number of Bidders* (Model 2A) are statistically insignificant. Models 1B and 2B set the treatment to 2016 for a comparison with the pre-treatment period of 2014–2015. The coefficients for the interaction terms from the estimates of models 1B and 2B fail to achieve conventional levels of statistical significance for one or two-tailed tests. These results suggest parallel trends due to the absence of a "false" treatment effect in the pre-treatment period.

The complete sample covering the period from 2014 to 2020 is used to estimate placebo models that involve changing the treatment to each year in the pre-treatment

Table 3. Results for Coefficients of Interest from Fixed Effects Placebo Estimates of the Nominal Low Bid and the Number of Bidders for Kentucky Transportation Cabinet Highway Asphalt Projects. Dependent Variable = Log of Low Bid (Model 1A, 1B, 1C, and 1D), Log of Number of Bidders (Model 2A, 2B, 2C, and 1D).

Variable	Model 1A	Model 2A	Model 1B	Model 2B	Model 1C	Model 2C	Model 1D	Model 2D
After repeal	0.017 (0.030)	–0.084 (0.114)	–0.059[b] (0.029)	0.101 (0.142)	0.056[b] (0.025)	–0.026 (0.102)	0.028[d] (0.020)	–0.018 (0.092)
State project	–0.006 (0.026)	–0.038 (0.129)	–0.009 (0.017)	–0.058 (0.089)	0.003 (0.023)	–0.047 (0.117)	–0.008 (0.015)	–0.089 (0.079)
After repeal x state project	0.014 (0.030)	–0.030 (0.118)	0.032 (0.026)	0.050 (0.110)	–0.018 (0.025)	–0.010 (0.116)	–0.008 (0.019)	0.046 (0.094)
N =	901	901	901	901	2,155	2,155	2,155	2,155
F=	45,105.2	123.4	37,361.9	288.8	10,790.2	13.66	12,226.5	12.34
R^2 (overall) =	0.988	0.288	0.988	0.285	0.988	0.254	0.988	0.251

Source: Unit Bid Tabulations, Kentucky Transportation Cabinet. Standard errors in parentheses are corrected for heteroskedasticity.
[a]significant at the 0.10 level;
[b]significant at the 0.05 level;
[c]significant at the 0.01 level (two-tailed tests).
[d]significant at the 0.10 level;
[e]significant at the 0.05 level (one-tailed test). To preserve panel data, three additional observations were removed for models A and B.

period. The first estimate falsely assigns the beginning of the treatment period to 2015 and tests for relative changes in the cost or level of competition for state projects, compared to the pre-treatment period of 2014. Results from this estimate are reported for models 1C and 2C. The second placebo estimate (models 1D and 2D) falsely assigns the beginning of the treatment period to 2016 for a comparison to the pre-treatment period of 2014–2015. Evidence from the interaction of the *After Repeal* and *State Project* variables from the estimates of models 1C, 2C, 1D, and 2D are consistent with those reported in Table 2. These findings indicate that the absence of a statistically significant difference in bid cost and bid competition between federal and state pavement projects after repeal in 2017 is a continuation of the trend during the pre-treatment period.

Conclusion

The wave of repeals of prevailing wage laws in six states between 2015 and 2018 was largely motivated by desires to reduce public construction costs. This study finds that repeal of prevailing wages in Kentucky did not alter relative bid costs or bid competition between state and federal highway pavement projects. Even after repeal, there is no difference in bid costs or competition between state projects that are not covered by prevailing wage regulations and federal projects that are covered by the Davis-Bacon Act and the Disadvantaged Business Enterprise policy. These findings are consistent with the preponderance of peer-reviewed research extending over more than 20 years.

Repeal efforts are based on the belief that higher wages mean increased costs. While this may be true in at some times in some industries, there is little evidence it applies to prevailing wages in the construction industry. The usual explanation is that, since labor costs are a low percent of overall construction costs, only minor changes in labor productivity and construction efficiency are needed to counter the cost effect of minimum prevailing compensation standards. Other, practical considerations may also explain the findings of this study. Pavement work on highways requires skilled labor to operate various types of complex equipment so that expensive and perishable hot asphalt materials can be applied correctly the first time. Even if contractors are legally entitled to reduce wages after prevailing wage repeal, the ability to retain workforce productivity may be problematic. Additionally, the majority of contractors involved in the pavement projects examined in this study switched between state and federal projects. For a variety of reasons, including employee morale and payroll record keeping, these contractors may have maintained compensation rates on state projects after repeal. Evidence of this practice is supported by a comment from a high-ranking employee of the Kentucky Transportation Cabinet who communicated to one of the authors that after repeal that, "Contractor's [sic] by and large had to continue paying them to gain qualified, skilled employees to perform the work." If the construction workforce and compensation did not change after repeal of Kentucky's prevailing wage law, there is no expectation that bids costs or bid competition would change.

The level of competition for the most common type of highway construction in Kentucky is very low relative to the same work in other states. Consequently, the cost-

reducing effect of increased bid competition is large. This finding suggests that efforts by the Kentucky General Assembly to increase competition would be far more effective in reducing bid costs than prevailing wage repeal.

Appendix

Table A. Fixed Effects Results for Coefficients of Interest from Alternative Specifications of Model 1 and Model 2. Dependent Variable = Log of Low Bid (Model 1A-E), Log of Number of Bidders (Model 2A, B, E), Number of Bidders (Model 2C).

Description	No Rejected Projects		No Post-Covid Projects		No Eng. Est.
Variable	Model 1A	Model 2A	Model 1B	Model 2B	Model 1C
After repeal	0.034	0.020	0.036[a]	–0.026	–0.152
	(0.018)	(0.075)	(0.020)	(0.080)	(0.164)
State project	0.011	–0.079	0.003	–0.055	–1.321[c]
	(0.012)	(0.066)	(0.013)	(0.072)	(0.122)
After repeal x state project	–0.023	–0.033	–0.023	0.035	0.195
	(0.018)	(0.077)	(0.021)	(0.081)	(0.184)
N =	1,859	1,859	2,002	2,002	2,155
F=	11,683.5	13.9	9,718.3	20.4	124.2
R^2 (overall) =	0.987	0.238	0.989	0.226	0.304

Description	# Bidders	State Projects Only	Projects with Miles > 0	
Variable	Model 2C	Model 1D	Model 1E	Model 2E
After repeal	0.003 (0.152)	0.018[c] (0.004)	0.029[a] (0.020)	0.015 (0.080)
State project	–0.052	—	–0.003	–0.055
	(0.124)		(0.014)	(0.073)
After repeal x state project	–0.030	—	–0.018	0.002 (0.081)
	(0.152)		(0.021)	
N =	2,155	1,770	2,108	2,108
F=	9.2	56,218.7	9,281.1	21.6
R^2 (overall) =	0.285	0.978	0.988	0.254

Source: Unit Bid Tabulations, Kentucky Transportation Cabinet. Standard errors in parentheses are corrected for heteroskedasticity.
[a]significant at the 0.10 level;
[b]significant at the 0.05 level;
[c]significant at the 0.01 level (two-tailed tests).
[d]significant at the 0.10 level;
[e]significant at the 0.05 level (one-tailed test).
To preserve panel data, one additional observation was removed for models A and B, four for Model D, and two for Model E.

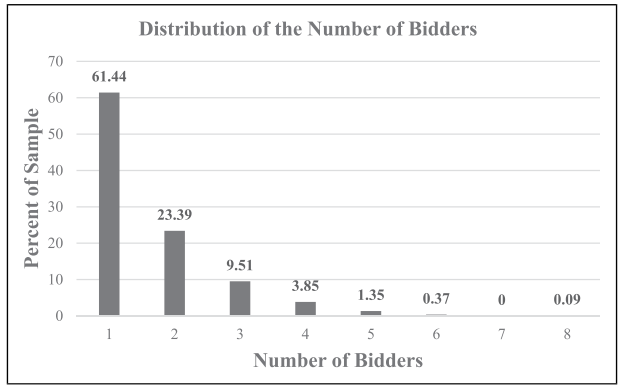

Figure A. Histogram Distribution of the Number of Bidders. Combined Federal and State Projects, 2014 to 2020. Source: Unit Bid Tabulations, Kentucky Transportation Department. Projects with Low Bids great than $250,000 included.

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Notes

1. For Information on state-level policies as of January 1, 2021 see USDOL, Dollar Threshold Amount for Contract Coverage under State Prevailing Wage Laws." Not included on this list are Colorado and Virginia. See Colorado Department of Labor and Employment (n.d.) and Virginia's Legislative Information System (2020) Session. For an example of a municipal-level prevailing wage standard see City and County of Denver (n.d.), "Prevailing Wage Rates."
2. These states are (repeal dates in brackets): Arkansas (2017), Indiana (2015), Kentucky (2017), Michigan (2018), Wisconsin (2017), and West Virginia (2016). References from each state reveal legislative concerns over costs as the main motivation for repeal. See State of Arkansas (2017), The Times (2015), BallotPedia (n.d.), U.S.News (2017), and The Intelligencer (2016).
3. The fringe rate was an additional amount per hour the employer paid on behalf of the employee for benefits such as health insurance, retirement, life insurance, and apprenticeship

program support. Fringe benefits did not include deductions required by law such as taxes, workers' compensation, or unemployment insurance. It also did not include costs associated with vacation and holiday pay. An employer had the option of paying an employee's fringes to the employee in cash or partly in cash and partly in benefits.

4. According to information provided by the Laborers-Employers Cooperation and Education Trust, teamsters unions do not participate in highway construction in Kentucky. Consequently, this task is performed by laborers. Operating engineers pilot power equipment involved in asphalt removal and application.
5. One way that standard construction polices are enforced is through the Kentucky Transportation Cabinet's Standard Drawings. This Standard establishes material quality and installation requirements that are the same for all projects, regardless of federal or state funding. See Kentucky Transportation Cabinet, "2020 Standard Drawings Roadway."
6. Using Kentucky Transportation Cabinet specific project descriptions, state-funded projects used in this study consist entirely of asphalt resurfacing. Federal projects include the following work descriptions: asphalt pavement and roadway rehabilitation, asphalt rehabilitation, asphalt rehabilitation with grade and drain, asphalt surface with grade and drain, asphalt pavement, asphalt pavement with grade and drain, and asphalt resurfacing.
7. Standard errors reported in Table 3 are corrected for heteroskedasticity.
8. The bid tabulations include information on the number of miles for a pavement project. The projects range in length up to 40 miles. While some projects have recorded miles as low as 0.06 miles, bid tabs for some federal projects report 0 miles, even when these projects include asphalt milling that takes place over some distance of a road surface. It is likely that an administrative rule, or practice omits the length of some projects from being reported. Regardless, the *Miles* variable has no statistically significant effects when the samples omit cases where this variable is equal to zero. For Model 1 the coefficient for the *Miles* variable is 0.013 (0.016). The coefficient for the *Miles* variable in Model 2 is –0.029 (0.063). For additional information on these estimates see Appendix Table A, models 1E and 2E. These results indicate that the *Miles* variable does not have an independent effect on the dependent variable when the engineer's estimate is included. The addition of the *Miles* variable does not alter the results of the DID analysis.

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