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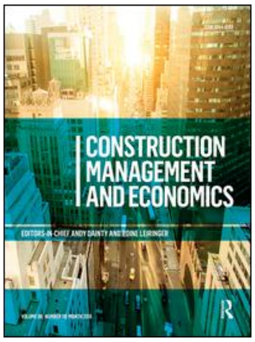

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The effect of prevailing wages on building costs, bid competition, and bidder behaviour: evidence from Ohio school construction

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ABSTRACT

The Davis-Bacon Act and other state prevailing wage laws are instituted to, among other things, protect local compensation standards from possible degradations associated with public construction and create a level playing field for all competing contractors. The impact of prevailing wages on the cost of construction projects to the taxpayers is an issue that continues to be debated at the state and federal levels. In this paper, data from recent school construction projects in Ohio are used to examine the impact of federal prevailing wage standards on construction costs and bid competition. Results from the examination of all bids and winning bids indicate that prevailing wage requirements do not have a statistically significant effect on building costs or the level of bid competition. Results from endogenous treatment estimators provide additional evidence that the prevailing wage policy does not increase costs or limit competition. Additional analysis of all bids indicates that the cost-reducing effect of increased competition is stronger on projects covered by the prevailing wage policy.

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Prevailing wage laws; construction cost; bidding; bid competition

Introduction

The Davis-Bacon Act of 1931 mandates that construction workers, employed on federally funded or federally assisted contracts in excess of $2,000, be paid (wages and fringe benefits) no less than the local prevailing rate for similar work in the area (U.S. Department of Labor 2015). The District of Columbia and 26 out of the 50 states, including Ohio, have also enacted state prevailing wage laws (hereinafter, PWLs) that apply to state funded projects (U.S. Department of Labor 2019a). These laws establish minimum wage and benefit rates by trade and location, typically by county, for construction workers employed on publicly funded projects. The primary intention of PWLs is to ensure that wages and benefits paid to construction workers on covered public projects will not be undercut by government spending practices (U.S. Department of Labor n.d.).

PWLs provide a level competitive playing field among bidders. Because large public projects in an area may attract contractors from other regions, a potential problem arises when builders from low-wage areas bid on these projects. The competition from out-of-area contractors (with lower wages) may pressure local builders to reduce compensation rates for their employees. This is a valid concern because the compensation rates of construction workers in the U.S. vary significantly across markets depending on several factors such as labour market supply and demand, and the cost of living in the specific market. For example, the average hourly wage paid to electricians in Ohio in 2018 was $25.54 (U.S. Bureau of Labor Statistics n.d.). Among Ohio's neighbouring states, average electrician wages vary from $31.68 (Pennsylvania) to $25.51 (Kentucky). Within Ohio, average electrician wages vary from $30.30 (Toledo) to $21.90 (Springfield). Consequently, an average-paying electrical contractor located in Toledo may have wage-cost concerns when competing on a local project with contractors from neighbouring states such as Kentucky and/or from other cities in Ohio such as Springfield. Prevailing wage rates for construction financed by the State of Ohio are based on negotiations between contractors who are signatories to collective bargaining agreements and labour unions (LAWriter n.d.). This minimum rate levels the playing

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field for all contractors and eliminates the pressure on the local contractors to reduce wages in response to competition from low-wage builders.

Regardless of wage differences, local contractors likely possess other competitive advantages over non-local builders. Through their experience in and familiarities with the place of their contracting business, local contractors are more knowledgeable about the procedures of the local authorities, workmanship requirements and quality standards, production cost information, networks of supplies, and manpower market conditions, etc. Non-local contractors typically do not have such local experience and knowledge. Nevertheless, PWLs ensure that the deterioration of local labour standards does not play a role when contractors compete for a project award.

Motivations for posted worker policies in the European Union (EU) parallel those of PWLs in the United States. A posted worker is an employee who is sent by their employer to work temporarily in another EU Member State (European Commission n.d.). As an example, a building contractor may be awarded work in another country and may send their employees to work on that project. An average of 45% of approved posted positions are in the construction sector with disproportionate representation from low-wage member states (De Wispelaere and Jozef 2016). A 2018 directive from the European Parliament establishes numerous protections including equal compensation for the same work in the same place for posted and resident employees (Laboris 2018). The motivation behind this policy is to protect worker wages, avoid the exploitation of low-wage foreign labour, and provide employers with a level playing field (European Parliament and Council of the European Union 2018).

PWLs in the United States are contentious and the subject of continuing academic research and policy debate. There are numerous institutional and regulatory arrangements that influence construction costs, but PWLs are particularly contentious because of the range of implications of this policy. For example, proponents argue that these regulations protect both the wages and jobs of local workers, enhance the local economy, promote the development of a skilled Labour force, reduce overall construction costs, promote work place safety, assure quality construction, reduce delays and cost overruns, help maintain local tax bases, and provide stability in the construction industry (State Building and Construction Trades Council of California n.d). Opponents, on the other hand, argue that PWLs increase construction project costs, impose unnecessary regulatory burdens and heavy paperwork requirements, reduce competition, discriminate against minority and small contractors, hurt rural contractors and workers, do not guarantee quality and do not increase local tax bases (Ohio Legislative Service Commission 2002).

Research has examined the effect of PWLs on apprenticeship training, injury rates, racial discrimination, and building costs, as reviewed by Duncan and Ormiston (2019). However, policy debates typically focus on the latter impact. For example, recent repeals and other changes that limited state-level PWLs in Arkansas, Indiana, Kentucky, West Virginia, and Wisconsin were driven by claims that the policy increases construction costs by as much as 15% (Davey 2015, Stratford 2015, WSAZ 2016, WHAS11 2017, Lombardo 2017). Due to general interest in the cost of public education, the effect of PWLs on school construction costs has been widely investigated.

This study contributes to the literature and policy debate by exploiting the unique opportunity presented by publicly available data for school construction in Ohio. With these data, we explore three different means through which prevailing wages may affect construction costs. We examine the effect of the prevailing wage regulations on project bid-costs, bid competition, as well as the effect of the policy of contractor bid behaviour and practices. The remainder of this paper is organised in the following sequence. In the next section, Ohio's prevailing wage law is discussed along with the unique case where school construction is regulated by the federal prevailing wage law. Economic theory regarding the cost impact of PWLs, and the complications of applying standard theory to the construction costs is described. The following section is a review of previous research on the three ways PWLs directly and indirectly affect building costs. The methodology section explains how the use of research in the policy debate regarding PWLs calls for a quantitative, positivist epistemology. Yet, the ultimate impact of prevailing wages on costs depends on what people (labour and management) at construction sites do. Sections on data, models, and results illustrate the three ways PWLs directly and indirectly affect construction costs. The discussion section provides a critical analysis of the results with comparisons to previous research. The limitations of the methods and data are described. Finally, the implications for policy and future research are discussed in the conclusion.

Ohio's prevailing wage law and school construction

Ohio's prevailing wage law became effective in 1931, the same year that the first federal prevailing wage law, the Davis-Bacon Act, was enacted (Liggett 2011). The prevailing wage rate for covered public projects in Ohio is the wage and benefit rate determined by the relevant collective bargaining agreement in the project's immediate locality (LAWriter n.d.). Since its inception, Ohio's prevailing wage law has undergone numerous revisions regarding the types of projects covered by the prevailing wage policy. In 1997 the State of Ohio ended the requirement that prevailing wages apply to state-funded school construction (Lohman 2006). Changes in 2011 prohibited school districts from voluntarily paying prevailing wages (Liggett 2011). Public school construction fully funded by the State of Ohio is not required to comply with the federal prevailing wage regulations. On the other hand, any school construction receiving federal assistance is covered by the Davis-Bacon prevailing wage regulations.

The U.S. Department of Education provided federal assistance for public school construction through the Qualified School Construction Bond Programme (QSCB) in 2009 (U.S. Department of Education 2009). Project funding was part of the American Recovery and Reinvestment Act of 2009 (ARRA) with a total of $22 billion distributed to states and large school districts between 2009 and 2010 (OFCC 2010). The State of Ohio received $419 million in 2009 and $430 million in 2010 for a total of about $849 million in QSCB funding. States could carry funds for future projects if the QSCB awards were not spent during the allocation period. Projects receiving QSCB funding were required to comply with ARRA provisions, including federal prevailing wage requirements.

In determining wage and benefit rates under the federal Davis-Bacon Act, the U.S. Department of Labor solicits contractors, trade associations, and unions regarding payment information on construction projects within a jurisdiction (typically a county or group of counties). Participation in the survey is voluntary (U.S. Department of Labor 2010). If the results of a survey indicate a majority wage rate for a particular job classification in a county, the majority wage is the prevailing rate. Union wage rates within jurisdictions are typically the same to the penny. Consequently, a majority wage is typically a union rate. If there is no majority wage, the prevailing wage is the average wage, weighted by total employment in the job classification. A similar process determines the prevailing benefit rate.

An average prevailing wage depends on the distribution of union and non-union wage rates collected in the survey. While union rates are determined by negotiations between contractors who are signatories to collective bargaining agreements and labour unions, wages paid by non-union contractors are influenced by individual bargaining and local labour market conditions for building trades occupations. There are no public data comparing union and non-union construction compensation, however, data from other sources typically find that non-union wage and benefit rates are lower. For example, Buckley et al. (2016) find that in the states of New York and New Jersey in 2016, non-union wage rates were approximately 70%, with benefits about 22% of corresponding union rates for selected construction occupations. PWLs establish minimum wage rates for construction workers employed on covered projects. For projects that are not covered by prevailing wage requirements, federal and state minimum wages apply. The current federal minimum wage in $7.25 per hour. States may establish minimums greater than the national wage floor. The current rate in Ohio is $8.55 (U.S Department of Labor 2019b). Since Ohio's prevailing compensation rates are based on local collective bargaining rates, the comparison of school projects built with prevailing wages to other public schools built without the prevailing wage policy is a strong test of the impact of the Davis-Bacon Act on the cost of construction services to the tax payers when union rates prevail.

The theory on prevailing wages and its impact on construction costs

Conventional economic theory implies that increased wage rates, in the presence of a fixed budget, result in decreased labour employment and reduced output by a firm (Ferguson, 1979). Or, the same level of production can only be maintained with increased expenditures by the producer. Therefore, standard economic theory implies that PWLs increase building costs. Standard theory also predicts that producers adjust to changes in wage rates by altering the use of labour and other inputs in ways that increase labour productivity. Researchers find evidence of this type of input substitution in the construction industry. Balistreri et al. (2003) and Blankenau and Cassou (2011) find that contractors in the U.S. make productivity and cost-saving adjustments by substituting skilled for unskilled workers as well as replacing labour with capital equipment when wages increase. These types of changes tend to temper the effect of increased wage rates on construction costs.

In addition to these adjustments, bid competition limits the ability of contractors to increase their bid prices due to higher wages: increasing their bid prices would make them less competitive. The uneven effect of PWLs across competing contractors escalates this constraint. For example, the labour costs and bids of builders who pay relatively high wages and employee skilled trades workers are not as affected by prevailing wage requirements. It is the low-wage contractor, who employs less-skilled workers who must adjust labour productivity and utilisation when bidding on prevailing wage work. Bid competition, particularly when high and low-wage contractors are involved, limits the ability of low-wage contractors to pass increased prevailing wage rates through to bid-prices. In a comparison of construction worker compensation in states with strong or average prevailing wage laws to states with weak or no laws, Duncan and Lantsberg (2015) find that material costs and contractor profit margins are lower when construction worker wages and benefits are higher. These findings suggest that reduced profit margins and other cost-saving efforts are ways builders absorb some of the costs of prevailing wages.

Labour costs are one factor of a contractor's bid and are a relatively small component of a builder's overall business. For all building types in the U. S., labour costs (wages and benefits) average approximately 23% of contractor construction value, net of work subcontracted to others, the costs of land acquisition, and architecture/engineering costs (U.S. Census Bureau 2012). Accordingly, relatively small changes in productivity or other cost-saving efforts are necessary to assuage the cost effect of higher prevailing wage and benefit rates. Ultimately, the combined effects of prevailing wages, attendant changes in labour productivity, and other cost-savings efforts on building costs is an empirical question.

A challenge of the research examining PWLs and construction costs has been the selection of a correct method. Prior to the availability of statistical software and electronic project records, early studies calculated the impact of PWLs on total costs by adjusting labour costs for the difference between prevailing rates and alternative compensation in the absence of the policy. For example, if labour costs represent 25% of total construction costs and average prevailing wages and benefits exceed average alternative compensation by 30%, the prevailing wage requirement increases total costs by 7.5% = (.25 × .3 × 100). The study by Keller and Hartman (2001) was the last academic study to use a wage difference approach (see Bilginsoy and Philips (2000) for a review of earlier studies). While this wage differential approach requires little data and is intuitive, it ignores the changes in worker productivity and utilisation, as well as the changes in material costs and contractor profits that accompany PWLs (Balistreri et al. 2003, Blankenau and Cassou 2011, Duncan and Lantsberg 2015). Consequently, the cost estimate obtained from this method is too high.

Research that exploit detailed project-level data and statistical software address the shortcoming of the wage differential method by examining the effect of PWLs on total construction costs. This broader cost measure captures the changes in input utilisation and productivity that construction managers and contractors make when prevailing wages are required. While researchers have examined the impact of PWLs on a variety of different construction projects, the research has focussed on school construction because taxpayers are particularly sensitive to policies that affect the cost of education (Duncan and Ormiston 2019). In addition, school construction is relatively homogenous with project-level data that is relatively easy to obtain. Unless indicated otherwise, the studies reviewed below are based on the regression analysis of project bid-prices since information on change orders that determine final (total) project costs are typically unavailable (see Duncan 2015). While model specifications vary between studies, the standard practice is to include other detailed project-level information such as measures of project size (square feet and number of stories), project complexity (distinguished by elementary, middle, and high schools), whether the project is new or an addition, and the stage of the business cycle, etc. This information allows for the measurement of the cost impact of the prevailing wage policy taking into consideration other project features that also influence construction costs.

Studies on prevailing wages and school construction costs

In an examination of cost differences between public and private schools built in states with and without PWLs over the 1991–1999 period, Azari-Rad et al. (2002) found that the policy does not have a statistically significant impact on the owner's construction costs. In a follow-up study, these authors took the strength of a state's prevailing wage law into consideration and reached the same conclusion (Azari-Rad et al., 2003). Using the same data source (Dodge Data & Analytics) as Azari-Rad et al. (2002, 2003) and an overlapping time period (1995–2004), Vincent and Monkkonen (2010) reported a statistically significant prevailing wage cost effect ranging between 8% and 13%. Differences in statistical models are likely responsible for the disparity in results between these studies. Azari et al. included more controls for the business cycle while Vincent and Monkkonen included measures of other policies that are also related to costs (school siting and state funding laws). The studies also differed in terms of sample sizes: Azari-Rad et al. used as many as 4,600–4,900 observations, while Vincent and Monkkonen used a sample of 2,645 observations.

Other studies examine the effect of PWLs on building costs within smaller jurisdictions. These studies are typically motivated by changes, or proposed changes to PWLs. For example, the 1997 policy change in Ohio triggered numerous studies. Results from these studies failed to find consistent evidence that PWLs, related policies, or union compensation rates increased the cost of construction projects. Atalah's (2013a, 2013b) comparison of average school construction bids submitted by union and non-union contractors found that PWLs did not increase construction prices. The Ohio Legislative Service Commission (2002) compared construction costs for schools built before and after Ohio's prevailing wage exemption in 1997 and did not find statistically significant cost savings after the exemption. Philips (2001) examined school construction costs in Kentucky, Michigan, and Ohio during periods in the 1990s when PWLs changed within these jurisdictions. The author found that there was no statistically significant difference in school construction costs as the states exempted school construction from PWLs, introduced PWLs, or repealed PWLs. Waddoups and May (2014) examined the effect of responsible contractor polices, that require contractors to provide health insurance, retirement benefits, apprenticeship training, or pay prevailing wages. These authors reported that schools built with responsible contractor requirements were no more expensive than schools built without the policy.

Wial (1999) examined the effect of a change in Pennsylvania's prevailing wage rates on school construction costs. In 1997, prevailing rates decreased in some counties from union rates to average levels. The comparison of building costs in these counites before and after these changes shows no statistically significant savings after the wage reduction. Prus (1999) examined construction costs between six mid-Atlantic states and between counties within Maryland that were and were not covered by PWLs. Results from either comparison indicate that building costs were not affected by state or county-level prevailing wage requirements. Manzo and Duncan (2018) found no statistically significant prevailing wage cost effect among schools built in the Minneapolis/St. Paul metropolitan in the state of Minnesota. Waddoups and Duncan (2019) examined school construction involving roofing and asphalt work within a county in the state of Nevada and failed to find a statistically significant prevailing wage costs effect.

Several studies have examined the introduction of the Skills Development and Fair Wage Policy in British Columbia. This policy was introduced in 1992 and established minimum wage and benefit rates for construction funded by the provincial government. Bilginsoy and Philips (2000) failed to find a statistically significant difference in winning bids among public schools that were built before and after the introduction of the Fair Wage Policy. In an examination of winning bids and all bids, Bilginsoy (1999) also found that the introduction of fair wages in British Columbia did not affect bid costs in a statistically significant way. Duncan et al. (2014) conducted a similar comparison but included a treatment group of public-school projects and a control group of private schools. These authors found that public schools were approximately 40% more expensive to build than comparable private schools prior to the introduction of fair wages. Others have suggested that public schools may be relatively more costly to build due to longer expected lifetimes or due to other regulations such as siting laws that limit where schools can be built (Azari-Rad et al. 2003, Vincent and Monkkonen 2010). Regardless of the source, the cost differential between public and private school construction did not change with the introduction of minimum wage requirements.

To determine why the introduction of a fair or prevailing wage standard did not affect construction costs, subsequent studies examined the effect of the British Columbian prevailing wage policy on the productivity and efficiency of construction. Duncan et al. (2006) reported that the size disparity between private and public schools did not change after the policy was introduced. This finding suggests that fair wage requirements did not alter construction methods in a way that significantly affected construction output, i.e., the relative size of public and private schools. Duncan et al. (2009, 2012) found that contractors lost some degree of efficiency in school construction with the introduction of the fair prevailing wage policy, but efficiencies were either restored, or stabilised in less than 18 months. Cumulative evidence from these studies suggests that increases in construction efficiency and productivity offset cost pressure associated with the payment of fair wages and stabilised the cost of school construction in British Columbia.

The preponderance of the research on PWLs and school construction costs does not support the implications of conventional economic theory regarding the effect of the policy on building costs. Rather, findings support the view that construction input productivity and utilisation, as well as other cost-saving efforts, offset minimum wage requirements.

Prevailing wages and bid competition

Other methods of examining the cost impact of PWLs involve the effect of the policy on the level of bid competition. A common claim is that PWLs discourage contractors from bidding on covered projects with the reduction in competition contributing to increased bid-costs (Leef 2010). There are four studies that empirically examine the effect of the policy on the level of bid competition, and all find that PWLs do not reduce the number of bidders. Two of these studies focus on school construction. In the examination of the school construction in British Columbia, Bilginsoy (1999) found that the level of bid competition on covered school projects increased with the introduction of the fair wage policy but diminished over time. Waddoups and Duncan (2019) found that school building projects covered by Nevada's prevailing wage standard did not have fewer bidders than projects that were not covered by the wage policy. Duncan (2015) found that federally funded highway construction projects in Colorado, that required the payment of prevailing wages, were no less competitive than projects that were funded by the State of Colorado and did not require the payment of prevailing wages. All these studies are based on the regression analysis of project-level data with models that are similar to those used in examining the effects of PWLs on construction costs. The study by Kim et al. (2012) is the exception. These authors examined various municipal projects in five northern California cities and found no statistically significant difference in the average number of bidders in projects that were and were not subject to PWLs.

Prevailing wages and bidder behaviour

PWLs may also affect construction costs by altering bidders' behaviour. For example, Bilginsoy (1999) claims that PWLs reduce contractor uncertainty in a way that results in a stronger effect of bid competition on bid-costs. This explanation is based on contractor reactions to the winner's curse when bidding on and off prevailing wage projects. According to the 'common values' model of auction theory, the winner's curse results from uncertainty that is shared by all bidders regarding the true value of the auctioned item. An implication of this model is that bidders are exposed to the winner's curse where the winner is the most optimistic, most likely to incorrectly estimate the value of the auctioned item, and likely to incur losses or low profits. Bilginsoy argues that in a construction bid setting without PWLs, contractors wishing to avoid undesirable outcomes associated with the winner's curse will add a margin, or surcharge to their bids. To provide additional protection from competition that drives bids lower, contractors will increase this margin as the level of competition increases. Because of rising margins, the decrease in bids associated with increased competition diminishes (in absolute value). At some threshold level of competition, the margin/surcharge effect is expected to overwhelm the competitive effect with bids increasing as the level of competition rises. On the other hand, a wage and benefit floor reduces uncertainty that all bidders share concerning the cost of the project. Consequently, there is less of a need for contractors to add a margin for protection from underbidding. In the application of these concepts to the introduction of British Columbia's fair prevailing wage policy, Bilginsoy hypothesises that before the policy all contractors shared uncertainty over the stability of wage rates, labour costs, and total project costs over the course of construction and faced the winner's curse. The introduction of the prevailing wage policy reduced common uncertainty over wages and labour costs for all contractors. Consequently, the threat of the winner's curse would diminish. Bilginsoy's examination of bids submitted by non-union contractors on British Columbian public school projects built between 1989 and 1995 indicates that bids increased with higher levels of competition before the fair prevailing wage policy. Bids decreased with increased bid competition after the introduction of fair wages. This pattern is consistent with expected contractor reactions to PWLs, uncertainty over bidding, and the winner's curse.

Methodology

Seymour et al. (1997), Dainty (2007), and others emphasise the need for greater diversity of research methods to more fully understand the management of construction. To this end, qualitative research methods, such as a case study approach would be appropriate in examining the managerial practices and social interactions at construction sites when prevailing wage do, and do not apply. The experiences of managers and employees could yield nuanced insight regarding specific differences in the division of labour, organisation of building activity, as well as the interactions between labour and supervisors when increased productivity is a managerial objective. This level of information is not available from the quantitative analysis of bids but may complement the results of such a study.

Different purposes require different research methods. Policy makers find research regarding the cost effect of PWLs useful when considering legislation. Quantitative methods are preferred in the policy debate due to the base features of positivist epistemology (objectivity, empiricism, determinism, and generality, etc.). Yet, qualitative social interactions at construction sites ultimately determine the effects of PWLs on construction costs. If 'people' (labour and management) at construction sites are successful in bringing about increased productivity when higher wages are paid, then PWLs are less likely to be associated with increased construction costs. If the efforts of the parties involved are not successful, the policy is likely to be associated with increased costs.

This study investigates the impact of prevailing wage requirement on construction costs and bid competition by analysing information obtained from the Ohio Facilities Construction Commission. These data are described in full detail in the following sub-section on Data Collection. Multiple regression is used to analyse these data in order to determine the relative influence of multiple independent variables on bid-costs and competition. The regression models are explained in the sub-section on Model Formulation.

Data collection

The Ohio Facilities Construction Commission (OFCC) provides information on capital construction projects for state agencies, state-supported universities and community colleges, and Ohio's public K-12 school construction and renovation programme (OFCC n.d.). Prior to 2013, information on state-sponsored K-12 construction did not contain complete information on school projects (OSFC n.d.). The data used in this study extend from August 2013 to October 2016. Over this period, there were 132 projects available from the OFCC that involve K-12 school construction. These projects consist of school construction that received state support. School construction funded entirely by local school districts is not included in this study as data for these projects are not available from the OFCC.

Since states could carry forward federal Qualified School Construction Bond Programme funds, projects covered by prevailing wage standards extend to at least 2016. Detailed project specifics available from Dodge Data & Analytics were used to identify those OFCC school construction projects that were covered by the Davis-Bacon Act. With this information, we were able to determine the prevailing wage status and obtain other complete information for 113 of the 132 OFCC school projects. The OFCC reports data on the low bid, identity, address, and number of participating contractors, school type (elementary, middle, etc.), and project type (new, renovation, and asbestos abatement, etc.), as well as the engineer/agency estimate of project cost. All projects in this analysis (irrespective of the prevailing wage requirement) were procured through open competitive bidding (open tendering). The complete record of all competing contractors allowed the researchers to examine the effect of PWLs on the low, winning bid as well as on all submitted bids. Specifically, the data allow for the examination of the effect of the policy on the low bids of 113 projects. Since there were approximately 5.9 bidders per project, we are also able to measure the effect of the policy on all 669 submitted bids. The information regarding the number of participating contractors also allowed us to determine if the level of bid competition differs for projects that were covered by the prevailing wage policy and those that were not.

Model formulation

The data on all bids and winning bids are applied to Model 1 (A and B) that examine the effect of prevailing wage requirements on project cost. The effect of prevailing wages and bidder behaviour is based on modifications to models 1A and 1B. Model 2 examines the effect of prevailing wage requirements on the level of bid competition.

Model 1 (A and B)

$$\begin{aligned} \mathit{Ln\,Real\,Bid} - \mathrm{Cos}\,t_{it} = {} & \beta_0 + \beta_1 \mathit{Prevailing\,Wage\,Project}_{it} \\ & + \beta_2 \ \mathrm{Ln}\ \mathit{Real}\ \mathit{Estimate}_{it} \\ & + \beta_3 \ \mathit{Bidders}_{it} + \beta_4 \mathit{Bid\,Place}_{it} \\ & + \beta_5 \mathit{Out} - \mathit{of} - \mathit{State}_{it} \\ & + \beta_6 \mathit{Franklin\,County}_{it} \\ & + \ \beta_7 \mathit{School\,Type}_{it} \\ & + \beta_8 \mathit{Project\,Type}_{it} + \beta_9 \mathit{Year}_{it} \\ & + \mu_{it} \end{aligned}$$

Model 1 is estimated separately for the sample of all 669 bids (Model 1A) and for the 113 low, winning bids

(Model 1B). This distinction allows for the examination of prevailing wage requirements on all bids (Model 1A) and winning bids (Model 1B). *Ln Real Bid-Cost* is the natural log of the inflation-adjusted bid for project *i* in time period *t*. The producer price index for construction materials available from the Bureau of Labour Statistics is used to control for changes in prices over time for the range of different project types that are included in this study (U.S. Bureau of Labor Statistics 2019). The use of a price index that does not include Labour costs allows other variables such as an identifier of projects requiring the payment of prevailing wages to measure the effect of labour costs on bid-costs. *Prevailing Wage Project* is a dummy variable equal to one for projects that were subject to Davis-Bacon prevailing wage requirements and zero otherwise. *Ln Real Estimate* is the natural log of the construction engineer's or agency's estimate of the cost of a project and is a measure of its size and complexity. Previous studies that focus on new school construction use square footage as the measure of project size (Azari-Rad et al. 2003). Since this study includes a variety of project types such as demolitions and new construction, the engineer's estimate is a better measure of the scope and complexity of a project, regardless of its specific type. If projects covered by PWLs tend to be larger or more complex than projects that do not require prevailing wages, omitting the engineer's estimate will result in a biased measure of the prevailing wage policy. According to information obtained from the OFCC, the engineer/agency estimate for school construction that receives state funding is based on 'publicly available wage rates' (prevailing wage and union rates). This has been the practice of calculating the engineer's estimate for the last 20 years and applies to all cases, regardless of whether Davis-Bacon requirements apply. This common standard of calculating the agency estimate avoids downward bias in the *Prevailing Wage Project* dummy variable. If the engineer's estimate is based on two wage rates, prevailing rates for prevailing wage projects and an estimate of open shop rates for projects that are not covered by the prevailing wage policy, the effect of the prevailing wage policy will be measured by the engineer's estimate and by the prevailing wage dummy variable. *# Bidders* is equal to the number of contractors that submitted bids on a project. The number of bidders is a measure of the level of competition which has the potential to affect the cost of a project. *Bid Place* is a continuous variable measuring the place of each contractor's bid (first, second, etc.) for a project. This variable is included in Model 1A that is based on the sample of all bids for a project (winning and all other bids) and measures the change in bid-costs between the first, second, third highest bidders, etc. When estimating the effect of prevailing wages on all bids, it is important to include a control for *Bid Place* as the effect of the wage requirements may vary from the low winning bid to higher bid places. *Bid Place* is omitted from the estimate of winning low bids (Model 1B). *Out-of-State* is equal to one if the winning contractor's business address is from outside of Ohio and zero for contractors with in-state addresses. The school construction projects included in this study are distributed across 16 counties in Ohio.[1] The populations of these counties range from 21,185 in Henry County in 2017 to approximately 1.3 million for Franklin County. Franklin County is home to the state capital and Ohio's largest city (Columbus). Average county population is 534,528 (standard deviation equals 537,404). Of the 113 projects examined in this study, approximately 48% were in counties with populations greater than the average. About 31% of all projects were in Franklin County. Thirty-four percent of projects were in counties with populations below 100,000.

Proximity to a more competitive supply chain, along with shorter distances between suppliers and work sites may contribute to reduced construction costs in more populated areas. On the other hand, demand for material costs may be higher in larger cities. To control for net differences between projects in smaller communities and in the state's largest city, the dummy variable *Franklin County* is included. This variable is equal to one for projects located in Franklin County and zero otherwise. *School Type* is a vector of dummy variables for work on elementary, middle, high, and other school types (such as community learning centres, combined schools, etc.). *Project Type* is a vector of dummy variables that distinguish between the following four groups of projects; (1) abatement and demolition work, (2) additions and new building construction, (3) electrical and mechanical work, and (4) renovation and site prep. *Year* is a vector of dummy variables measuring distinctions between 2013 and 2016. The error term is μ.

Model 2

$$\begin{aligned} \mathit{Ln\ Bidders}_{it} = \beta_0 &+ \beta_1\, \mathit{Prevailing\ Wage\ Project}_{it} \\ &+ \beta_2\, \mathit{Ln\ Real\ Estimate}_{it} \\ &+ \beta_3\, \mathit{Franklin\ County}_{it} + \beta_4\, \mathit{School\ Type}_{it} \\ &+ \beta_5\, \mathit{Project\ Type}_{it} + \beta_6\, \mathit{Year}_{it} + \mu_{it} \end{aligned}$$

While Model 1 focuses on the effect of prevailing wage requirements on project costs, Model 2

Table 1. Summary statistics for Ohio school construction, all bids, 2013–2016.

Variable	Projects with prevailing wages			Projects without prevailing wages		
	Mean	Min	Max	Mean	Min	Max
Real Low Bid (measured in USD)	$5,522,545* (6,729,696)	$52,279	$26.7**	$2,053,782(3,948,374)	$20,397	$2.14**
Real Estimate (measured in USD)	$5,372,850*(6,363,975)	$91,308	$2.35**	$ 2,164,817(4,221,019)	$46,793	$1.96**
# Bidders (# contractors/project)	8.076* (3.24)	2	15	6.884 (2.31)	1	12
Bid Place (rank of each contractor bid)	4.508* (2.98)	1	15	3.916 (2.37)	1	12
Out-of-State Contractors (range: 0–1)	0.130* (0.34)			0.241 (0.43)		
Franklin County (Columbus) (range: 0–1)	0.819* (0.39)			0.072 (0.26)		
Elementary School (range: 0–1)	0.769* (0.42)			0.626 (0.48)		
Middle School (range: 0–1)	0.193* (0.40)			0.056 (0.23)		
High School (range: 0–1)	0.021* (0.14)			0.102 (0.30)		
Other School (range: 0–1)	0.017* (0.13)			0.216 (0.41)		
Abatement & Demolition Projects (range: 0–1)	0.403* (0.49)			0.631 (0.48)		
Additions & New Building Construction (range: 0–1)	0.441* (0.50)			0.146 (0.35)		
Electrical & Mechanical (range: 0–1)	0.067 (0.25)			0.081 (0.27)		
Renovation & Site Prep (range: 0–1)	0.088* (0.28)			0.142 (0.35)		
N =	238			431		

The statistics reported above were derived from data obtained from the Ohio Facilities Construction Commission. Standard errors in parentheses. *The mean for projects with prevailing wages is different at the 0.05 level from the comparable mean for projects without prevailing wages. **Millions of dollars.

measures the effect of the prevailing wage policy on the level of bid competition. In Model 2 the natural log of the number of bidders is the dependent variable. All the independent variables from Model 1 are included in Model 2 except for the dependent variable *(#Bidders*), *Bid Place*, and the measure of out-of-state contractors (*Out-of-State)*. Both models examine the effect of the variable of primary importance, prevailing wage requirements, and take into consideration differences in project size/complexity, type, and other factors that may also affect building costs and bid competition. All models are estimated with the STATA 15 statistical software.

Results

Summary statistics for 238 bids submitted on school projects covered by prevailing wage regulations and 431 bids submitted on projects that were not affected by the prevailing wage policy between 2013 and 2016 are presented in Table 1. These data indicate that the average for all bids and the engineer's estimates are higher for prevailing wage projects. Both measures are approximately $5.5 million and $5.4 million, respectively. On the other hand, average bids and engineer's estimates are approximately $2.1 million for projects that were not covered by the wage requirement. The number of bidders is also higher on prevailing wage projects. These projects attract an average of about 8 bidders while projects that do not require the payment of prevailing wages average 6.8 bidders. The average bid place is higher for prevailing wage projects (4.5) compared to uncovered projects (3.9) because of the larger number of bidders on prevailing wage projects. Fewer out-of-state contractors bid on prevailing wage projects (13%) while approximately 24% of contractors on projects that do not require prevailing wages are from other states. This difference is consistent with the view that the prevailing wage policy protects work for local contractors and their employers. About 82% of prevailing wage bids were submitted on projects located in Franklin County (location of the City of Columbus) and approximately 7% of projects without the wage requirement were built in this county. About 96% of prevailing wage projects involve work at elementary and middle schools while 4% of the prevailing wage projects involve work at high schools and other education building. The corresponding figure for projects that were not covered by the prevailing wage policy is approximately 68% for elementary and middle schools and 32% for high schools and other education building. About 40% of bids on prevailing wage projects involve abatement and demolition work while 63% of bids on projects without prevailing wages involve this type of work. Approximately 44% of bids on prevailing wage projects involve additions and new building construction while only about 15% of non-prevailing wage bids involve this type of work. The differences in percent of work involving additions and new building construction between projects that do and do not require the payment of prevailing wages likely explains the differences in average low bids, the engineer's estimate and the number of bids as the construction included in this category is relatively more expensive and attracts more contractors. All the differences described above differ at the 0.05 level. Electrical and mechanical construction makes up about 7% of prevailing wage bids and about 8% of bids on non-prevailing wage projects, but these differences are not statistically significant. Bids on renovation and site preparation work make up about 9% of bids on prevailing wage projects and about 14% of bids on non-prevailing wage projects. This difference is significant at the 0.05 level. Summary data for the 113 low bids is reported in Appendix Table A. These data are similar to those for all bids reported in Table 1.

Regression results are reported in Table 2. The estimates have been corrected for heteroskedasticity. The focus variable in all models is Prevailing Wage Project with primary interest in how prevailing wage requirements affect bid-costs (Models 1A and 1B) and bid competition (Model 2). Results for estimates based on all bids and winning bids (Models 1A and 1B) indicate that bids for projects covered by prevailing wages regulations are no higher, in terms of statistical significance, than bids on projects that are not covered by the prevailing wage policy. These results do not change when the models are estimated without the measure of project size and complexity (*Ln Real Estimate)* or the number of bidders (*Ln# Bidders*). The coefficients for the prevailing wage variables when *Ln Real Estimate* is omitted from Model 1A and Model 1B are 0.028 (standard error = 0.17) and –0.121 (standard error = 0.36), respectively. The coefficients for the prevailing wage variables when *Ln# Bidders* is omitted for Model 1A and Model 1B are –0.021 (standard error = 0.04) and 0.025 (standard error = 0.11), respectively. Results do not vary from those reported in Table 2 when nominal measures of contractor bids and the engineer's estimate are included in Models 1A and 1B.

Other results for Models 1A and 1B indicate that the coefficients for the engineer's estimate for both models are close to unity, indicating that bids rise proportionately with estimated project costs. All bids, or winning bids decrease by about 3% with the addition of another competing contractor. Results for Model 1A indicate that bids differ by approximately 6% between bid places. That is, there is a 6% difference between the second and third bid and between the 10th and 11th bid. The coefficients for out-of-state contractors suggest lower bids, but no statistical significance can be assigned to these differences. All bids or winning bids submitted in Franklin County are no higher than bids in other counties in terms of statistical significance.[2] Results for Model 1A indicate that bids for work at elementary, middle, and high schools are lower compared to the reference category (community learning centres, combined schools, etc.). This is not the case for winning bids for Model 1B. Results for Models 1A and 1B indicate that all the work-type categories (additions & new building construction, electrical & mechanical work, and renovations & site preparation) are more expensive than the reference category (abatement & demolition work). Results for each model indicate that there is no statistically significant difference in bids submitted within this study period. The coefficients of determination from Models 1A and 1B are high and consistent with other studies that include measures of estimated project costs (see De Silva et al. 2003, Duncan 2015).[3]

In Model 2, the dependent variable is the log of the number of bidders with the sample limited to

Table 2. Regression results for all bids, winning bids, and the number of bidders for Ohio school construction, 2013–2016.

Variable	Model 1A Coefficient	Model 1B Coefficient	Model 2 Coefficient
Prevailing Wage Project	–0.001 (0.04)	0.059 (0.12)	0.298 (0.19)
Ln Real Estimate	0.968 (0.01)***	1.020 (0.02)***	0.169 (0.04)***
# Bidders	–0.030 (0.01)***	–0.027 (0.01)***	–
Bid Place	0.061 (0.01)***	–	–
Out-of-State Contractor	–0.025 (0.03)	–0.090 (0.07)	–
Franklin County (Columbus)	0.017 (0.04)	–0.040 (0.12)	–0.234 (0.19)
Elementary School	–0.103 (0.03)***	–0.054 (0.06)	0.252 (0.12)*
Middle School	–0.171 (0.05)***	–0.098 (0.12)	0.272 (0.19)
High School	–0.120 (0.04)***	–0.014 (0.08)	–0.226 (0.19)
Additions & New Building Construction	0.190 (0.04)***	0.213 (0.09)**	–0.899 (0.19)***
Electrical & Mechanical	0.257 (0.04)***	0.251 (0.07)***	–1.055 (0.20)***
Renovation & Site Prep	0.165 (0.03)***	0.200 (0.07)***	–0.666 (0.14)***
2014 Bid	–0.056 (0.06)	–0.068 (0.16)	0.064 (0.37)
2015 Bid	–0.064 (0.07)	–0.085 (0.17)	0.028 (0.38)
2016 Bid	–0.069 (0.07)	–0.063 (0.17)	0.256 (0.35)
Constant	0.400 (0.14)	–0.321 (0.30)	–0.404 (0.67)
$N =$	669	113	113
$F =$	5,042.49	1,377.05	6.58
$R^2 =$	0.989	0.991	0.407

The statistics reported above were derived from data obtained from the Ohio Facilities Construction Commission. Standard errors in parentheses. *Statistically significant at the 0.1 level. **Statistically significant at the 0.05 level. ***Statistically significant at the 0.01 level.

winning bids ($N = 113$). Results indicate that the level of bid competition on prevailing wage projects is no different, in terms of statistical significance, from projects that are not covered by the policy. Other results for Model 2 indicate that more contractors are attracted to larger projects. The elasticity of the number of bidders with respect to the engineer's estimate indicates that a 1% increase in estimated project cost is associated with an approximate 0.17% increase in the number of competing contractors. The effect is significant at the 0.01 level. The level of bid competition is no different in Franklin County than in other counties. The level of bid competition is only higher for construction at elementary schools, relative to the reference category (community centres, etc.). This difference is significant at the 0.05 level. The number of bidders is greater in all the work-type categories (additions & new building construction, electrical & mechanical work, and renovations & site preparation) compared to the reference category (abatement & demolition work). There is no statistically significant difference in the level of bid competition.

Results from alternative specifications

The estimate of Model 1A that includes the interaction of *Ln #Bidders* and *Prevailing Wage Project* variables provides support for Bilginsoy's (1999) observation that contractors add a margin to their bids as protection from underbidding when competing on projects that are not covered by prevailing wage standards. The implication of Bilginsoy's argument is that the effect of another bidder on project bid costs will be larger (absolute value) on projects that are covered by the prevailing wage policy. When the interaction of the #Bidders and Prevailing Wage Project variables is included in Model 1A, the partial derivative, ∂ *Ln Real Bid Cost*/∂ *#Bidders* = –0.020 – 0.018 *Prevailing Wage Project*. Both coefficients are statistically significant at the 0.01 level. The standard error of the first coefficient is 0.004 and 0.006 for the second (interaction) coefficient. The results of the interaction indicate that another bidder on a school project that is not covered by prevailing wages reduces bid costs by approximately 2.0% (when *Prevailing Wage Project* equals 0 in the equation for the partial derivative). The corresponding decrease on a project that is covered by prevailing wages is 3.8% (when *Prevailing Wage Project* equals 0 in the equation for the partial derivative). When the interaction term is included in the estimate for the sample of winning bids (Model 1B), the coefficient for the interaction term fails to achieve conventional levels of statistical significance.

Another specification addresses the issue of endogeneity with respect to the treatment variable. If an unobserved variable influences the outcome term (*Ln Real Bid-Cost)* and the treatment measure (*Prevailing Wage Project*), there is an endogeneity problem that precludes the consistent measurement of the treatment effect. For example, school districts with greater political influence may be more effective in securing Quality School Construction Bond funds that also require the payment of prevailing wages. If these districts also build more expensive schools, there is an endogeneity problem since a district's political power influences whether a project requires the payment of prevailing wages and its cost. The two-step endogenous treatment estimator available in STATA (versions 14 and higher) is used to address this concern. The first step involves a probit regression of factors determining the treatment effect with the residuals from this estimate included in the second step estimate of the outcome model (*Ln Real Bid-Cost)*. Results are reported in Appendix Table B. In this case, *Prevailing Wage Project* is estimated as a function of a dummy variable identifying those districts with the largest enrolments, where district size is a proxy for political influence. Of the 22 districts included in the sample, seven had enrolments over 5,000 students over the study period. These large districts include Akron Public Schools, Columbus City Schools, Lancaster City School District, Lebanon City School District, Milford Exempted Village School District, and South-Western City School District.

The variable measuring the size and complexity of the project, *Ln Real Estimate* is also included to determine if larger projects are more likely to require the payment of prevailing wages. Results from the sample of all bids indicate that prevailing wage requirements are more likely in larger districts and on larger, more complex projects. These differences are significant at the 0.01 level. Results from the estimate of the outcome model, based on the sample of all 669 bids, indicate that bid-costs are 15% lower on prevailing wage projects. This is based on Kennedy's (1981) recommended interpretation of the percentage change for the coefficient for a dummy variable in a semi-log estimate is given by ($e^{\beta i}$–1), or in this case, $e^{-0.163}-1 = 0.150$. This difference is significant at the 0.01 level. This finding does not imply that winning bids on prevailing wage projects are 15% lower. This estimate is based on all independent variables, including *Bid Place*, equalling their average value (4.1), and not *Bid Place* equalling one. Other outcome model results reported in Appendix Table B are similar to those reported in Table 2 for Model 1A. Wald test results suggest that the identifying variables are highly statistically significant, and the model is unlikely to suffer from weak identification. When the model is estimated for winning bids only, the coefficient for *Prevailing Wage Project* is positive (0.106) but fails to achieve conventional levels of statistical significance. Additionally, the statistic for the Wald test of independence is 0.12 (p-value $= 0.731$) suggesting weak identification of endogeneity. This estimate would only converge when the measures of school type were omitted.

The endogeneity issue may also apply to the estimate of the level of bid competition (*Ln #Bidder*, Model 2). For example, if districts with greater political influence build more expensive schools, that attract more bidders (as indicated by the results for *Ln Real Estimate* in Model 2, Table 2,) there is an endogeneity problem since a district's political power influences whether a project requires the payment of prevailing wages and the level of bid competition. While the endogenous treatment estimator for *Ln #Bidder* is not reported in Appendix Table B, the results are consistent with those reported in Table 2 for Model 2. The coefficient for *Prevailing Wage Project* is positive (0.484), but not statistically significant (standard error $= 0.34$). The statistic for the Wald test of independence when LN #Bidders is the dependent variable in the endogenous treatment estimator is 0.057 (p-value $= 0.451$) suggesting weak identification of endogeneity.

Discussion

The goal of this study was to examine the effect of federal prevailing wage requirements on the cost of building schools in Ohio. Prevailing wage requirements may directly increase contractor bid costs by increasing wage rates. The policy may indirectly influence costs by altering the level of bid competition or bidder behaviour. Based on the regression analysis of school projects built between 2013 and 2016 our findings show that winning bids, as well as bids submitted by all participating contractors, are not related in terms of statistical significance, to prevailing wage and benefit rates that are based on union compensation levels. Similarly, the prevailing wage standard does not alter the level of bid competition on these projects but is associated with more aggressive bidding as the number of bidders increase. These results do not support the implications of conventional economic theory regarding the effect of increased wages on production costs. Rather, the findings are consistent with alternative explanations suggesting that contractors and construction managers adjust input productivity and utilisation, as well as other costs to PWLs in ways that offset inflationary effects of the policy. Our findings are consistent with the preponderance of previous research as well as all other studies that examine the effect of increased Labour compensation on school construction in Ohio (Philips 2001, Ohio Legislative Service Commission 2002, Atalah 2013a, 2013b, Waddoups and May 2014,). These studies, based on different methods, data, and periods, yield cogent results indicating that the 1997 exemption of schools from Ohio's prevailing wage law was not associated with savings of taxpayer dollars as was promised by proponents of the exemption.

Other studies have examined implications of PWLs with multi-pronged approaches. Duncan et al. (2006, 2009, 2012, 2014) examine cost, productivity, and efficiency implications with this body of research providing comprehensive and consistent results indicating that the introduction of the fair wage policy in British Columbia was not associated with increased construction costs. The current study mirrors the approach used by Bilginsoy (1999) by examining the effect of a PWL on construction costs, bid competition, and bidder behaviour. The benefit of a multi-pronged analysis is that by more fully exploiting the data, a more comprehensive view of the policy is revealed. If the results of all approaches are consistent, they provide a more convincing view of the effect of the policy. Had the current study focussed solely on the relationship between prevailing wage requirements and bid-costs, the results may be more easily dismissed as unique to the data, time period, or model specification, etc. The power of this study is enhanced by a more comprehensive approach.

Statistical comparisons of projects that are, and are not covered by PWLs are confounded by the non-standardization of construction work. As noted by Philips (2003), construction projects differ because they are uniquely designed and require customised work. If project differences are not included in statistical comparisons, the measured impact of PWLs may be subject to unobserved and uncontrolled heterogeneity bias. Research focuses on school construction partly due to general interest in the cost of public education, and partly due to the relative homogeneity of these building types. School construction projects, even new school buildings, differ with respect to specialised classrooms and other factors related to size and complexity that involve different types of work and construction costs. This paper addresses the issue using detailed measures of project size (the engineer's estimate of project cost) and controls for specific work types (demolition, renovation, and electrical work, etc.) Waddoups and Duncan (2019) also address the problem of project heterogeneity by focussing on asphalt and roof work and controlling for the estimated project costs in their examination of school construction in Clark County, Nevada. None of the other reviewed studies addresses the issue of heterogeneity as extensively. The studies by Atalah (2013b) and Manzo and Duncan (2018) control for specific types of work, but do not include the engineer's estimate as a measure of project complexity. All the other studies rely on the number of project square feet as a measure of project size and controls for project characteristics, such as new or additional construction and work on an elementary, middle, or high schools as measures of project complexity. However, these measures are not as complete as those used in this study and the study by Waddoups and Duncan (2019).

Limitations

The ability to generalise the results of this study to PWLs in other areas of the U.S., or for different periods is limited by the unique characteristics of prevailing wage requirements for the Ohio schools and the market forces examined here. For example, the wage requirements, in this case, may be considered "strong" as the prevailing rate is the union wage and benefit rate. Results may be generalised to other jurisdictions where union rates prevail such as the states of New York or Washington. However, results of a similar analysis may differ in regions where prevailing wages are based on the average compensation rate. Similarly, the results described here are based on a period of economic expansion as the building industry in Ohio and across the nation recovered from the 2008 Great Recession. Superior data would examine the effect of PWLs over the course of the business cycle.

Our results do not provide insight regarding *why* PWLs are not associated with increased building costs. The absence of a statistically significant prevailing wage cost effect may be due to a combination of factors such as increased labour productivity, savings on material costs, reduced profit margins, competition that limits the ability of contractors to pass increased wages through to bid-costs, or some other considerations when prevailing wages are required. The analysis needed to explore these issues is beyond the quantitative, positivist epistemology underling this study. Different methods, data, and information are needed to fully explore how the work at construction sites and bid accounting change when prevailing wages apply. Such research is important as the results may complement or contradict those obtained from the statistical analysis of project-level data.

In many cases, PWLs can be considered exogenous, or given in the statistical examination of construction costs. The policy may be endogenous in other circumstances where the characteristics or actions of project owners, or funders jointly influence whether prevailing wages are required and construction costs. In these situations, it is necessary to employ appropriate estimation methods. For the Ohio school projects included in this study, larger school districts may build more expensive schools and these districts may possess greater political influence in securing the federal funding that also requires the payment of prevailing wages. Our attempts to address this issue were only partially successful. Results from the estimation of a two-step endogenous treatment estimator indicate that it is only with a low level of statistical confidence that the results for the estimates of the low bid and the number of bidders are not subject to endogeneity bias.

Conclusion and recommendations

Opponents of PWLs often claim that the policy increases construction costs directly through increased Labour costs, or indirectly by limiting bid competition. These claims are made with selective or incomplete reference to the academic research on these issues. The preponderance of research based on the statistical analysis of project bid-prices indicates that the prevailing wage policy has no measurable effect on construction costs and that the policy does not limit bid competition. Results from the analysis of recent school construction projects in Ohio lend further support to the general findings. Specifically, the examination of all bids and winning bids on recent school construction projects indicates that projects covered by the federal Davis-Bacon Act are no more expensive, or less competitive than projects that do not require the payment of prevailing wages. Additional results find that the effect of another bidder on bid costs is stronger when prevailing wages apply. This effect may contribute to stable costs on projects that are covered by the prevailing wage policy. From an international perspective, the rich literature on PWLs implies that recent reforms in the EU regarding minimum compensation standards for posted workers should not increase construction costs or reduce the level of bid competition.

Future statistical analysis of construction costs should not only examine the relation between prevailing wage requirements and bid prices but should also expand our understanding of the effect of the policy on the level of bid competition and bidder behaviour regarding the winner's curse. Future analysis should also examine the possibility of endogeneity with respect to prevailing wage standards in jurisdictions where the policy is not exogenous. There are opportunities for further research in this area with data from other states that have experienced changes in PWLs, including Wisconsin, Indiana and West Virginia.

While additional quantitative studies based on project-level data may add to or contradict the current preponderance of evidence, future research could use qualitative methods to compare the organisation of labour and management of construction sites with and without prevailing wage requirements. These methods would address key issues that are not revealed by quantitative analysis.

Notes

1. These counties include Ashland, Athens, Clermont, Crawford, Defiance, Fairfield, Franklin, Hardin, Henry, Lawrence, Miami, Pickaway, Sandusky, Shelby, Summit, and Warren.
2. In terms of statistical significance, the coefficients for the Prevailing Wage Project variables are not affected by the omission of the Franklin County variable. The coefficients (and standard errors) for Prevailing Wage Project are 0.013 (0.016), 0.027 (0.042), and 0.107 (0.094) for models 1A, 1B, and 2, respectively. When the large county variable is redefined to include all counties with populations greater than the average (534,528), the results are similar to those when the Franklin County variable is included in the estimates. The coefficients (and standard errors) for the large county variables are 0.020 (0.026), −0.005 (0.065), and −0.069 (0.142) (0.147) for models 1A, 1B, and 2, respectively. Using the new large county variable, instead of the Franklin County variable, has no effect on the coefficients for Prevailing Wage Project variables which are 0.020 (0.026), −0.004 (0.065), and 0.156 (0.147) for models 1A, 1B, and 2, respectively.
3. The coefficients of determination for models 1A and 1B are large because project bid-costs are estimated as a function of the engineer's estimate of project costs. The elasticities for Ln Real Bid with respect to *Ln Real Estimate* for these models are approximately one indicating a very close relation between project bids and estimated costs. This reflects the ability of engineers to accurately estimate the market value of projects. When Models 1A and 1B are estimated with Ln Real as the only independent variable, R^2 values are equal to 0.982 and 0.985. Variance inflation factors (VIF) suggest that multi-collinearity does not contribute significantly to the large coefficients of determination or to the fundamental conclusions of the findings. For example, the mean VIF for Model 1B is 5.11. VIF values exceed a value of 10 for the year control variables. When Model 1B is estimated without the collinear year dummy variables, the mean VIF decreases to 2.59. Regardless of the estimate, the VIF for the variable of interest (Prevailing Wage Project) is less than 5 (3.84 for Model 1B and 2.84 for the revised estimate of Model 1B). Regardless of the modification of Model 1B, the coefficient for Prevailing Wage Project remains statistically insignificant. The slope term changes to 0.073 (standard error of 0.088) when the year dummy variables are omitted. Results regarding VIF are similar for Model 1A.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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Appendix Table A. Summary statistics for Ohio school construction, low bids, 2013–2016.

	Projects with prevailing wages			Projects without prevailing wages		
Variable	Mean	Min	Max	Mean	Min	Max
Real Low Bid (measured in USD)	$5,472,049*(6,801,063)	$52,279	$2.46**	$2,043,158 (4,112,679)	$20,397	$2.11**
Real Estimate (measured in USD)	$5,495,871* (6,594,437)	$91,308	$2.35**	$ 2,205,236 (4,335,488)	$46,793	$1.96**
# Bidders (# contractors/project)	6.833* (2.95)	2	15	5.766 (2.60)	1	12
Out-of-State Contractors (range: 0–1)	0.028* (0.17)			0.221 (0.42)		
Franklin County (Columbus) (range: 0–1)	0.778* (0.42)			0.091 (0.29)		
Elementary School (range: 0–1)	0.750* (0.44)			0.558 (0.50)		
Middle School (range: 0–1)	0.194* (0.40)			0.052 (0.22)		
High School (range: 0–1)	0.028* (0.17)			0.130 (0.34)		
Other School (range: 0–1)	0.028* (0.17)			0.260 (0.44)		
Abatement & Demolition Projects (range: 0–1)	0.333* (0.48)			0.545 (0.50)		
Additions & New Building Construction (range: 0–1)	0.444* (0.50)			0.156 (0.37)		
Electrical & Mechanical (range: 0–1)	0.111 (0.32)			0.130 (0.34)		
Renovation & Site Prep (range: 0–1)	0.111* (0.32)			0.169 (0.38)		
N =	36			77		

The statistics reported above were derived from data obtained from the Ohio Facilities Construction Commission. Standard errors in parentheses. *The mean for projects with prevailing wages is different at the 0.05 level from the comparable mean for projects without prevailing wages. **Millions of dollars.

Appendix Table B. Endogenous treatment effect regression of all bids and wining bids for Ohio school construction, 2013–2016.

	Model 1A		Model 1B	
	Probit regression	Linear regression	Probit regression	Linear regression
Variable	Coefficient	Coefficient	Coefficient	Coefficient
Prevailing Wage Project	–	–0.163 (0.5)***	–	0.106 (0.21)
Large District	1.313 (012)***	–	1.089 (0.29)***	–
Ln Real Estimate	0.150 (0.03)***	0.989 (0.01)***	0.128 (0.08)*	1.018 (0.02)***
# Bidders	–	–0.028 (0.01)***	–	–0.029 (0.01)***
Bid Place	–	0.060 (0.01)***	–	–
Out-of-State Contractor	–	–0.025 (0.02)	–	–0.010 (0.06)
Franklin County (Columbus)	–	0.020 (0.04)	–	–0.040 (0.11)
Elementary School	–	–0.096 (0.03)***	–	–
Middle School	–	–0.193 (0.05)***	–	–
High School	–	–0.113 (0.04)***	–	–
Additions & New Building Construction	–	0.160 (0.04)***	–	0.204 (0.08)**
Electrical & Mechanical	–	0.298 (0.04)***	–	0.237 (0.08)***
Renovation & Site Prep	–	0.185 (0.03)***	–	0.203 (0.06)***
2014 Bid	–	0.064 (0.07)	–	–0.061 (0.16)
2015 Bid	–	0.076 (0.08)	–	–0.072 (0.19)
2016 Bid	–	0.060 (0.07)	–	–0.067 (0.18)
Constant	–3.221 (0.43)	0.049 (0.16)	–2.885 (1.029)	–0.329 (0.31)
N =	669	669	113	113
Log Likelihood =	–340.81	–	–58.882	–
LR χ^2 =	189.33	–	23.67	–
Pseudo R^2 =	0.217	–	0.167	–
Wald χ^2 =	–	59,266.40	–	23,591.36
Wald Test of Independence χ^2 =	–	20.22	–	0.12

The statistics reported above were derived from data obtained from the Ohio Facilities Construction Commission. Standard errors in parentheses. *Statistically significant at the 0.1 level. **Statistically significant at the 0.05 level. ***Statistically significant at the 0.01 level.
Probit Regression Dependent Variable = Prevailing Wage Project (Model 1A and 1B). Linear Regression Dependent Variable = Log of All Bids (Model 1A), Log of Low Bid (Model 1B).