TIMELY CONSTRUCTION: THE EFFECT OF PROJECT LABOR AGREEMENTS ON TIME TO COMPLETION FOR PUBLIC WORKS CONSTRUCTION IN SACRAMENTO COUNTY, CALIFORNIA

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Unique to the construction industry, project labor agreements (PLAs) are pre-hire labor contracts between project owners and unions. The impact of PLAs is debated among industry stakeholders, scholars, and policymakers. While prior research on PLAs has focused on construction costs and bid competition, this is the first known study to assess whether PLAs affect project duration. Through an analysis of 313 public works construction projects in Sacramento County, California, the authors find that PLAs are associated with 15 to 17% faster time to completion than non-PLA projects when controlling for factors such as project cost, project type, and awarding agency. Further, PLA projects are 43% more likely to be completed in the following year than non-PLA projects. This study supports the notion that PLAs protect construction contractors and owners from risk and promote faster completion of projects by ensuring access to skilled labor and harmonizing work arrangements across the various trades.

Project labor agreements (PLAs) are pre-hire collective bargaining agreements—typically between construction project owners and local building trades councils—that establish the terms and conditions of employment on a construction project. PLAs harmonize union agreements and commonly include provisions banning work stoppages, strikes, and lockouts. In return for some concessions, PLAs require that the majority if not all

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workers come from union hiring halls and generally allow for construction companies to work on those projects regardless of union affiliation. PLAs can protect construction contractors and owners from risk and promote timely completion of projects by securing access to union hiring halls and aligning work scheduling provisions across trades. While PLAs have been used for nearly a century on both private and public works construction jobs, former President Biden's Executive Order No. 14063 (2022), requiring PLAs on large-scale federal projects with total costs at or over $35 million, calls for broader understanding and research on PLAs, particularly on public works construction.

Because public works are funded by taxpayers, the impact of PLAs on public works project outcomes has been debated across scholars and practitioners alike. Proponents argue that PLAs promote timely completion of construction projects by providing stable access to a trained workforce, improving construction timeliness and efficiency, promoting compliance with labor standards, and advancing better workplace safety outcomes and higher quality standards without compromising on bid competition (e.g., Belman and Bodah 2010; Belman et al. 2010; Philips and Waitzman 2021). Opponents argue that PLAs raise the cost of construction projects, discourage competition, and create bureaucratic bottlenecks that slow down projects (e.g., Bachman and Haughton 2007; Tuerck, Glassman, and Bachman 2009). Research is needed to reconcile these conflicting arguments, aid policy decisions about PLAs, and clarify their effects on construction outcomes.

Our study is the first in the literature to examine the effect of PLAs on time to completion and assess whether stable access to union labor also shortens the duration of projects. Examining time to completion is crucial because construction delays and extended project timelines delay the infrastructure and buildings that taxpayers have invested in, while restricting worker availability on other public projects. Delayed public works infrastructure has significant social and financial costs beyond just the initial cost of the project, such as disruptions to community services and resources and transportation times for workers across industries. We analyze 65 PLA and 248 non-PLA public works construction projects in Sacramento County, California, between 2019 and 2023. Expanding upon the burgeoning field of PLA research, this study not only provides a new dimension to analyze PLA effectiveness but also incorporates data on infrastructure projects as well as school construction, the latter being the most common focus of prior research. Beyond contributing to the research field, this study also provides evidence for policymakers and construction owners of the impacts of PLAs on public works construction.

Background

Unique to the construction industry, PLAs are pre-hire labor contracts between construction project owners and construction unions, typically local

building trades councils or other representative multi-craft organizations.[1] First adopted in the 1930s on large federal contracts (Button 2019), PLAs sought to neutralize labor disputes and attract workers to long-term projects in areas far from their homes through standardized pay and other work agreements (GAO 1998; Mayer 2010). PLAs aim to address construction industry issues such as short-term employment, and more precisely predict labor demand and total project costs to provide an accurate bid and provide a steady supply of available workers. PLAs cover work for specific construction projects and may be negotiated individually or mandated by an agency or owner to apply to all projects exceeding certain valuation thresholds. Common provisions address worker dispatch, holiday and vacation time, wages, benefits, apprentice utilization, dispute resolution, and other work arrangements (GAO 1998; Belman, Bodah and Philips 2007).[2] PLAs may also attract owners because they provide access to union workers who may yield higher productivity (McFadden, Santosh, and Shetty 2022). PLAs may minimize conflicts in work arrangements across the various trades, supporting faster time to completion.

While PLA provisions vary across agreements, the most consistent elements prohibit strikes, work stoppages, and employer lockouts, and typically provide an expedited dispute resolution process for addressing jurisdictional issues between crafts or violations of the agreement provisions. Although PLAs on public works projects do not require contractors to be signatory to a collective bargaining agreement with a union to work on the project, they do require contractors to hire the majority of workers through union halls (Kotler 2009). On public works projects governed by prevailing wage regulations, prevailing wages set a floor on PLA negotiated wages (Dunlop 2002). Usage of union labor, health and welfare trust contributions, and support for joint apprenticeship programs motivates crafts to sign PLAs and align work agreements with those of other trades (Belman et al. 2007).

PLAs are also increasingly used for workforce development, especially when a robust supply is continually needed to fill construction jobs funded by recent historical investments in infrastructure (AGC 2022). Many PLAs have expanded to Community Workforce Training Agreements (CWTAs), with provisions to prioritize local hiring, increase apprenticeship utilization, and create pathways to construction career opportunities for economically disadvantaged and historically excluded workers (Herrera, Waheed, Koonse, and Ovando-Lacroux 2014). This can be an effective tool for meeting gender and racial diversification goals (Chimienti 2002; Parkin 2004; Figueroa, Grabelsky, and Lamare 2013). Advocates also tout PLAs as a tool

[1]A craft is a specialized trade within the construction industry, each with distinct and separate scopes of work (e.g., carpentry, electrical, plumbing).

[2]The PLAs referenced in this study do not include penalties for failure to complete a project. These kinds of stipulations are likely to be found in the individual contracts for each project, rather than the PLA.

to attract and retain workers, particularly during worker shortages (Manzo and Bruno 2024).

PLAs have faced legal disputes and presidential executive orders from five of the last six US presidential administrations,[3] often along partisan lines. At the state level, two states banned the use of PLAs in the 1990s; an additional 22 states prohibited PLAs on state and local public works in the 2010s.[4] California has its own legal history with PLAs: In a 1999 case, *Associated Builders and Contractors [ABC] v. San Francisco Airport Commission*, ABC claimed that the presence of a PLA on the San Francisco Airport Project violated competitive bidding laws.[5] The court rejected the notion that PLAs limit fair competition, stating that "the PLA is not anti-competitive merely because certain bidders would see some of its features as less attractive." California has since supported public PLAs: In 2011, California Governor Jerry Brown signed SB 922, preventing local entities from banning PLAs with the exception of charter cities who, as a result of the ban, would be ineligible for state funding on such projects.[6] Most recently, former President Biden's PLA mandate on projects over $35 million was the first order to date that requires the use of PLAs on federal construction.[7] California recently approved a bill to require PLAs on major state construction projects over $35 million, stating that "project labor agreements have proven to be a successful construction management tool of the efficient completion of public projects."[8]

Economic Research on Project Labor Agreement Outcomes

Advocates argue that PLAs offer an opportunity for collaboration across crafts and contractors on complex projects to standardize work arrangements, help grow apprenticeship programs, and improve productivity, efficiency, and safety outcomes (Kopp and Gaal 1999; Belman et al. 2010). Opponents claim that PLAs suppress bid competition, increase construction costs, and can involve lengthy bureaucratic processes for negotiating the agreement (Baskin 1998; Bachman and Haughton 2007; Bachman, Burke, and Tuerck 2019). Research on the impacts of PLAs on key construction outcomes focuses on construction costs, bid competition and bid

[3]In the 1993 *Building and Construction Trades Council v. Associated Builders and Contractors of Massachusetts/Rhode Island* (113 S. Ct. 1190), the U.S. Supreme Court ruled that nothing in the NLRA precludes public agencies who are owners of public works construction projects to use pre-hire agreements.

[4]As of December 2024, 24 states currently prohibit the use of PLAs at the city, county, and local level: Alabama, Arizona, Arkansas, Florida, Georgia, Idaho, Iowa, Kansas, Louisiana, Michigan, Mississippi, Missouri, Montana, Nevada, North Carolina, Oklahoma, North Dakota, South Carolina, South Dakota, Tennessee, Utah, Virginia, West Virginia, and Wisconsin.

[5]21 Cal. 4th 352 (Cal. 1999) 87 Cal. Rptr. 2d 654 981 P.2d 499.

[6]See California Public Contract Code 2500(a).

[7]Note that Section 5 of the mandate provides for exceptions that may be granted by a senior official within an agency. How widespread the usage of these exceptions is remains to be seen.

[8]See Senate Bill 574.

costs, and community benefits. Peer-reviewed economic research on PLAs (see Ormiston and Duncan 2022) evaluates their impact on public school construction costs, focusing on bid costs (the estimated project cost) or final costs (the final amount after completion). Factors such as materials, supply-chain delays, and project complexity pose challenges for isolating PLAs as a distinct driver of costs over and above other factors. Because PLAs are often used to simplify and address issues on large projects, there may be a positive association between the presence of a PLA and costs, making direct comparisons challenging. As Table 1 shows, this, in part, contributes to a larger range of public policy reports on PLAs and fewer peer-reviewed studies, with only six to date.

Much of the peer-reviewed research, albeit sparse, that uses robust models to account for characteristics widely known to impact construction costs (Belman et al. 2010; Waddoups and May 2014; Philips and Waitzman 2021) has found no statistically significant relationship between PLAs and cost increases. Specifically, after including controls such as the engineer's estimate and the year and month the project was awarded, Philips and Waitzman (2021) found no statistical evidence that PLAs raise public community college costs in California. Further, in the most comprehensive study of cost impacts accounting for many additional variables such as whether a school has a gym, a pool, or a kitchen, among many others, Belman et al. (2010) found PLAs had no statistically significant effect on costs. Finally, Waddoups and May (2014) analyzed school construction projects in Ohio built under "responsible contracting policies" (RCPs) that closely resemble the features of PLAs. After controlling for factors including geography, year, square feet, and more, the authors did not find evidence that RCPs are associated with higher costs.

Conversely, Bachman and Haughton (2007) controlling for size (square feet) and whether the project was new or a renovation, found that public school PLAs in Massachusetts were associated with cost increases.[9] A more comprehensive, though non-peer-reviewed, study by Ward (2021) analyzed PLA cost impacts on affordable housing projects in California, incorporating controls such as unit numbers, project timelines, and project development costs, and found a 14.5% increase in costs.[10] Recently, Lopezlira and Farmand (2024) replicated Ward's study but used actual total development costs rather than projected costs, and found the opposite result: no statistically significant evidence that PLA projects are associated with higher costs.

Peer-reviewed research on bid competition is even more limited. Philips and Waitzman (2021), the only peer-reviewed study examining bid

[9]Comparably lean models used in public policy reports have similar findings that PLAs increase the cost of construction (Bachman, Chisholm, Haughton, and Tuerck 2003; Bachman, Haughton, and Tuerck 2004; Bachman and Tuerck 2017). Belman et al. (2010) suggested that these models likely suffer from omitted variable bias.

[10]See also Philips and Littlehale (2015) on the impacts of PLAs on affordable housing construction costs in California, which found that PLA projects were not more expensive than non-PLA projects.

Table 1. Peer-Reviewed Research on Project Labor Agreements (PLAs)

Title/Author(s)/Date	*Sample*	*Geography*	*Impact/Findings*	*Affiliation/ Acknowledgements*
"Do Project Labor Agreements Reduce the Number of Bidders on Public Projects? The Case of Community Colleges in California" Peter Philips & Emma Waitzman (2021)	263 bid openings	CA	The number of bidders on a project was not altered by the presence or absence of PLAs. This study also finds that relative to engineer's estimates available on 99 of these projects, the lowest bids on PLA projects were not higher than the lowest bids on projects without PLA agreements.	Peter Philips is a Professor of Economics at the University of Utah. Emma Waitzman received her BA from Swarthmore College and received her master's in public policy and JD from the University of Michigan.
"Community Workforce Agreements: A Tool to Grow the Union Market and to Expand Access to Lifetime Careers in the Unionized Building Trades" Maria Figueroa, Jeff Grabelsky & J. Ryan Lamare (2013)	185 negotiated agreements, a survey of more than 300 building trades councils, and three case studies	Washington, DC; Cleveland; and NY	This paper profiles and explores variations in the nature and extent to which community workforce provisions have been effectively negotiated into PLAs.	This research was made possible by a grant from the American Rights at Work Education Fund. Maria Figueroa is Director of Labor and Industry Research at Cornell University's School of Industrial and Labor Relations (Cornell ILR), Extension and Outreach Division. Jeff Grabelsky is Director of the Construction Industry Program at Cornell ILR, Extension and Outreach Division. J. Ryan Lamare is a Research Analyst at American Rights at Work and Research Associate at Cornell ILR.

(continued)

Table 1. Continued

Title/Author(s)/Date	*Sample*	*Geography*	*Impact/Findings*	*Affiliation/ Acknowledgements*
"Project Labor Agreements' Effect on School Construction Costs in Massachusetts" Dale Belman, Russell Ormiston, Richard Kelso, William Schriver & Kenneth Frank (2010)	70 school construction projects	MA	Lean specifications find that PLAs raise the cost of school construction, however, this does not characterize more complete specifications that better fit the data. More complete specifications suffer from multicollinearity and over-determination.	Data collection was supported by a grant from the Center to Protect Workers' Rights. Dale Belman, School of Labor and Industrial Relations, Michigan State University; Russell Ormiston, Department of Economics, The College of Wooster; Richard Kelso, School of Architecture and Design, University of Tennessee; William Schriver, Construction Industry Policy and Research Center, University of Tennessee, Knoxville; Kenneth Frank, College of Education, Michigan State University, East Lansing.
"Do Project Labor Agreements Raise Construction Costs?" Paul Bachman & Jonathan Haughton (2007)	126 school construction projects	MA	Regression results show that PLAs raise the cost of school building by between $12 and $20 per square foot, or by between 9 and 15% of total costs.	Paul Bachman, Beacon Hill Institute, Suffolk University, Boston; Jonathan Haughton Department of Economics and Beacon Hill Institute, Suffolk University, Boston.
"Public Project Labor Agreements: Lessons Learned, New Directions" John Lund & Joe Oswald (2001)	N/A	N/A	Literature Review	N/A
"The Case against Union-Only Labor Project Labor Agreements in Government Construction Projects" Maurice Baskin (1998)	N/A	N/A	Literature Review	Maurice Baskin is a partner with the Washington, DC, law firm of Venable, Baetjer, Howard & Civiletti, LLP. He focuses on all aspects of labor and employment law representing management and serves as General Counsel of Associated Builders and Contractors, Inc.

competition, analyzed 263 bid openings for public community college building projects in California over a 9-year period, and controlled for the location in which the project occurred, project size, and the business cycle and season. They found the number of bidders on a project was not affected by the presence or absence of a PLA. Some policy reports on PLA bidding argue that non-union or open shop contractors are discouraged from bidding on jobs with a PLA because they require contractors to contribute to union benefits plans, follow union work rules, and hire employees through union halls, which raises costs (Bachman and Tuerck 2006; Bachman et al. 2019). In a policy report examining 125 projects in the state of Washington, Bachman et al. (2019) controlled for the number of employed workers in the state as a business activity proxy and project size, and found the use of PLAs resulted in 0.84 fewer bidders on average. Despite these policy reports, more peer-reviewed research is needed to understand the relationship between PLAs and bid competition.

No peer-reviewed studies to date have examined project time to completion. One policy report found that most PLA projects awarded by Illinois' Capital Development Board were completed early, on time, or within a month of the estimated completion date (Manzo and Bruno 2015). PLAs likely impact time to completion by providing access to a trained labor force through union procedures; harmonizing wages, hours, vacation, and other conditions; dispute resolution including jurisdiction and safety issues; and on-the-job and investments in training for a local qualified labor supply for quick workforce mobilization. As with costs, time to completion is challenging to analyze, for the added reason that project completion dates are commonly extended through "change orders," or agreements between an owner and contractor that additional time or costs are needed. Thus, a project may undergo many extensions to the original completion date, coming to market much later than initially expected, but could still be considered "on time." For this reason, a careful analysis of the relationship between PLAs and time to completion is an essential contribution to infrastructure literature given that time to completion is a highly critical metric to taxpayers. Time to completion represents a taxpayer's real ability to use a completed project funded by taxpayer dollars, which is especially salient considering the increasingly frequent use of PLAs on public works projects.

Project Labor Agreements in Sacramento County, California

California utilized public PLAs as early as the 1938 Shasta Dam, with the California Public Contract Code authorizing local agencies to apply them on public works projects.[11] While in the case of Shasta Dam there was one PLA covering one project, PLAs can cover multiple projects under a single agreement. In 2001, the California State Library counted 23 public-sector

[11]California Public Contract Code Chapter 2.8. Project Labor Agreements § 2500.

PLAs covering an unknown number of separate projects (Johnston-Dodds 2001). Currently, in addition to many single-project PLAs, there are 30 awarding agencies with PLAs in place that are applied to any agency project meeting a specified valuation threshold (AGC 2022). Two of these agency PLAs are the subject of this study.

In 2005 the Sacramento City Unified School District (SCUSD) became the first awarding agency in Sacramento County to authorize a PLA between the school district and the Sacramento-Sierra Building & Constructions Trades Council (SSBCTC), mandating that it apply to all projects over $1,000,000. The PLA was subsequently renewed in both 2012 and 2014. On November 17, 2017, the city council voted to lower the valuation threshold to $500,000.[12] At the same time, the City of Sacramento began to discuss the prospect of an agency-wide PLA, covering projects awarded by the City of Sacramento over $1,000,000.[13] In late 2018, the City of Sacramento finalized their Community Workforce Training Agreement which, in addition to traditional PLA provisions, included language to promote targeted hiring of underrepresented and economically disadvantaged communities. At the time of data collection, SCUSD and the City of Sacramento were the only two agencies with agency-wide PLA mandates in Sacramento County (i.e., every other school district and city agency in Sacramento County did not have an agency-wide PLA mandate). In fact, during data collection, the City of Sacramento renewed their PLA, with Sacramento Mayor Darrell Seinberg stating, "with PLAs, we get the certainty of knowing that a project is going to get done timely and with quality."[14]

Both the PLA and CWTA contain standard wage provisions and contributions to multi-employer trust funds. Unlike standard labor–management agreements—which are singular craft agreements—the PLA and CWTA are made on behalf of the entire building and construction trades council. Workers performing covered work under the agreements are precluded from engaging in strikes, picketing, work stoppages, or other interferences with work, while contractors are prohibited from issuing lockouts, differentiating PLAs from many standard labor–management agreements. The agreements also establish a grievance procedure for alleged violations of the CWTA as well as processes to address any jurisdictional disputes between the crafts. Notably, this includes the Northern California Brotherhood of Carpenters, who are otherwise not part of the SSBCTC, promoting project-specific peace agreements. While both agreements outline hiring provisions, the City of Sacramento CWTA also includes local hire requirements. The Sacramento CWTA states that "where a subject covered by the provision of this Agreement is also covered by a Master Agreement, the provision of this Agreement shall prevail," and the

[12]Project Labor Agreement for the Sacramento Unified School District.

[13]Community Workforce and Training Agreement City of Sacramento.

[14]City of Sacramento City Council Meeting, August 15, 2023. Accessed June 13, 2024, https://sacramento.granicus.com/player/clip/5648?view_id=22&redirect=true

SCUSD PLA states that "the provisions of this Agreement shall take precedence over conflicting provisions of any Master agreement." Both agreements have provisions for joint labor–management meetings, the purpose of which includes advancing the "proficiency and efficiency of the craft workers," with discussions of "safety, craft resource requirements, scheduling and productivity of work performed at the Project." These provisions may not be included in non-PLA projects, whether there is a craft Master Agreement or not.

The SCUSD PLA directs contractors to utilize the "registration facilities and referral systems established or authorized by the Unions signatory to this agreement." That is, consistent with traditional PLA provisions, contractors primarily locate and hire workers through local union hiring halls. Both agreements stipulate that contractors not signatory to a union may use "core" employees, up to eight under the school district PLA and up to four under the City of Sacramento CWTA. In other words, any winning non-signatory contractor and their subcontractors may employ this maximum number of core employees. The remaining employees must be hired through the union hall of the applicable crafts. Core employees must meet several requirements, including minimum hours worked in the construction craft during the prior two years, employment on the Contractor's active payroll for a specified period of time, and possessing the proper license. The City of Sacramento CWTA also requires core employees to be City of Sacramento residents, establishing an objective that "not less than fifty percent (50%) of the combined journey-level and apprentice hours worked on the Project . . . be worked by residents of the Local Area." The agreement outlines priority hiring in the local area, starting with residents of the city, residents outside the city but in Sacramento County, and residents in nearby counties in Northern California. Neither agreement dictates apprentice utilization, and the CWTA establishes "Priority Apprentices," which are those who reside in an economically disadvantaged zip code and who satisfy one of several eligibility criteria, including veterans, prior offenders, public assistance recipients, foster youth, homeless individuals, and/or women.

Methods

Sample

The City of Sacramento PLA offers a unique opportunity to expand research beyond schools to include city-agency projects. However, because the application of Sacramento City's PLA to specific projects is triggered only above a given project-value threshold, this city PLA is only and always applied to larger, more complex projects and never to smaller and potentially simpler projects. Finding appropriate comparisons between PLA and non-PLA city projects requires turning to surrounding cities for larger city-agency projects. There are multiple school districts within Sacramento

County but outside Sacramento City. Even though some of these districts also cross over into parts of Sacramento City creating non-PLA projects within the confines of Sacramento City, more comparisons are available by including non-PLA school projects outside Sacramento City. These facts invite expanding our sample to include school and city projects outside of Sacramento City but within Sacramento County.

Focusing on a single county also ensures that all projects were completed in localities that draw from a similar local labor market; all 13 cities in our sample outside of Sacramento City are within 35 miles of the Sacramento City Center. Moreover, by controlling for agency type, namely, school and city agencies, we ensure that PLA and non-PLA projects are of similar relevance to their communities. For example, both PLA and non-PLA projects included middle school roofing, high school HVAC replacements, elementary school modernizations, street resurfacing, bike trail enhancements, and building new community centers.

To locate projects awarded by comparable agencies, the authors searched for projects awarded by school districts and city agencies in Sacramento County registered on the PWC-100, California's public online database of public works projects.[15] The search criteria included projects that were estimated to be awarded and completed no earlier than January 1, 2019, when the City of Sacramento PLA mandate went into effect, and no later than December 31, 2022. We chose this time frame because we wanted a start date that began with the Sacramento City PLA, and we wanted to capture projects that were likely to be completed by the time of data collection in spring 2023. To find projects of comparable value, we searched for all projects awarded by the seven school districts in Sacramento County over \$500,000 (n = 248), and all projects awarded by the six city agencies in Sacramento County over \$1,000,000 (n = 88), for a total of 336 projects.[16] To determine PLA status on the projects awarded by Sacramento City Unified School District and City of Sacramento—the two agencies in Sacramento County with PLA mandates at the time of data collection—we used the thresholds included in the PLAs themselves (e.g., projects over \$500,000 for Sacramento City Unified School District and over \$1,000,000 for City of Sacramento). We then consulted industry professionals and members of the local Building and Construction Trades Council to confirm.

We further specified our sample to determine the actual number of days with recorded working hours on the project. Beginning on January 1, 2016, all contractors and subcontractors on public works projects in California are required to furnish electronic certified payroll records (eCPRs) to the labor

[15]See https://www.dir.ca.gov/pwc100ext/externallookup.aspx. Since our data were collected, California's Department of Industrial Relations (DIR) has updated its public works database and eCPR database, both of which have been undergoing maintenance.

[16]We excluded ongoing maintenance contracts such as "tree trimming service" or "on-call services," as we would be unable to determine time to completion for these contracts.

Table 2. Number of Ongoing and Completed Projects by Project Labor Agreement (PLA) Status

	Non-PLA	*PLA*	*All projects*
Ongoing projects	15	6	21
Completed projects	233	59	292
Total	248	65	313

commissioner. These records are publicly available on the Division of Labor Standards Enforcement's eCPR database. Viewers can locate records by entering various search criteria. For this study, we searched for eCPRs for the 336 Sacramento public works projects in our initial sample, 313 of which had eCPRs available. Of these, 292 projects had been completed, and 21 projects were still ongoing at the time of data collection. Our sample contains 65 projects with PLAs: 59 completed and 6 ongoing (see Table 2). There were 231 school projects and 82 city projects in the data. All projects in the sample are covered by the same California prevailing wage laws.

Note that of the 292 completed projects, according to eCPR records, only 64 projects ended prior to the March 19, 2020, stay-at-home order issued by Governor Gavin Newsom.[17] The remaining 228 completed projects, to varying extents, took place during the coronavirus pandemic. As such, our sample captures the pandemic business cycle, which, across many industries, featured supply chain bottlenecks and labor shortages. Construction was no exception as an industry that is highly sensitive to fluctuations in the business cycle. Given the labor shortages experienced during the pandemic—and the goal of PLAs to ensure a steady supply of skilled labor on construction projects, which can reduce the time to completion—the pandemic provides an informative case study of the impact of PLAs on time to completion, particularly during economic downturns and emergency situations.

Models

We employ two estimation methods to analyze time-to-completion differences between PLA and non-PLA projects. Time to completion was chosen over on-time completion for several reasons. First, on-time completion depends on an interpretation of completion as based on the original contract date, or an extended contract date resulting from change orders. Change orders may be viewed as mutually agreed-upon changes, creating circumstances whereby a project may technically be completed on time after going through several extensions. Ultimately, time to completion is highly critical to the public, and this methodology allows us to assess

[17]Although shortages in both materials and labor were present at the time, Governor Newsom exempted workers in the construction industry from the stay-at-home order.

whether a PLA affects how quickly taxpayers reap the benefit of their investments.

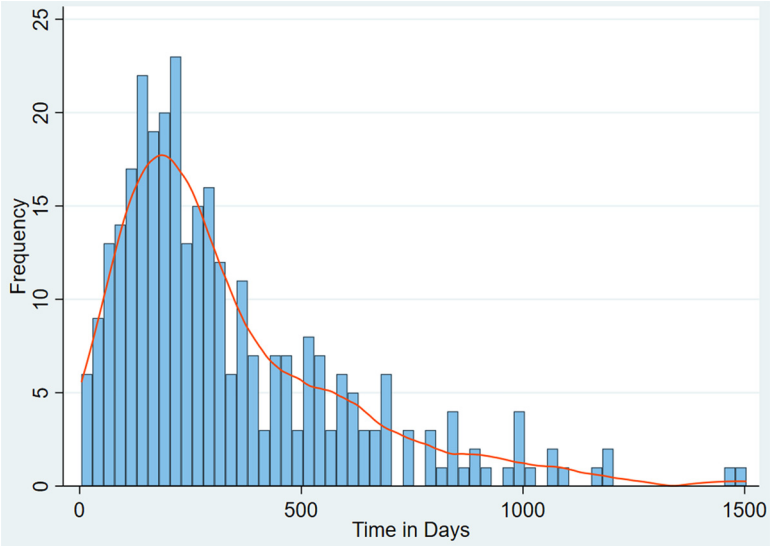
Using the 292 completed projects, our first estimation method is ordinary least squares (OLS) regression with city-clustered robust standard errors. The dependent variable is $Log\ Days_i$, the natural log of the number of calendar days between the first and last working day of project i according to eCPRs. The natural log is used to normalize an otherwise skewed data set; skewness and kurtosis tests indicate statistically significant levels of skewness in the distributions of the days and cost variables. Additionally, the natural log allows for the interpretation of model results in percentage-change terms. The independent variable of interest is PLA_i, an indicator with a value of 1 if project i was governed by a PLA, and 0 otherwise. The main OLS model for this study is the following:

$$(1)\quad \begin{aligned} Log\ Days_i = {} & \beta_0 + \beta_1 PLA_i + \beta_2 Log\ Cost_i + \beta_3 Agency\ Type_i + \beta_4 Project\ Type_i \\ & + \beta_5 Construction\ Type_i + \beta_6 Non\text{-}Urban_i + \beta_7 Start\ Year_i + \beta_8 End\ Year_i + \epsilon_i. \end{aligned}$$

The model is best characterized as descriptive. Ultimately, 21 construction projects—nearly 7% of all projects in our total sample of 313 projects—remained ongoing and unfinished at the time of data collection. Six of these unfinished projects were PLA projects; the other 15 were non-PLA projects. This outcome reflects right-censoring, a phenomenon in which an event—in this case, the completion of a construction project—is not experienced for certain observations in a sample by the time of data collection, suggesting the need for survival analysis (Allison 2010). Right-censoring can occur in construction project data for two reasons. First, a construction project may have been scheduled to finish prior to the time of data collection but may be delayed. Second, a construction project may be scheduled to be completed at a later date, but that date had not yet been reached at the time of data collection. In either case, it is not entirely clear how long after data collection these projects will be completed. Yet, regardless of when a construction project is completed, it can be completed at any point in time, not just at discrete points.

Further, the likelihood that a construction project is completed should increase over time; as a result, the estimated hazard function should then exhibit positive duration dependence. This condition implies that the sign of the shape parameter, ρ—the estimate of duration dependence—should be positive. Positive duration dependence violates the proportional hazards assumption on which estimation methods such as Cox proportional hazards models are based (Allison 2010). As a result, our second estimation method is survival analysis with a parametric hazard rate model that treats time as continuous, since construction projects can finish at any point in time. With our dependent variable of interest being time to completion, we utilize a time-to-failure framework, with the "failure" defined as the completion of the construction project. This approach allows us to estimate the likelihood of completion in the following year for PLA and non-PLA

Figure 1. Distribution of the Number of Calendar Days



Notes: Figure depicts our hazard rate model time variable, the number of calendar days between the first and last working day of each construction project.

projects with our full sample of 292 completed projects and 21 right-censored observations.[18]

Figure 1 presents a histogram of our hazard rate model time variable, the number of calendar days between the first and last working day of each construction project. As Figure 1 suggests, the distribution of this variable approximately follows a Weibull distribution. Additionally, we tested for model fit with multiple assumed distributions: Weibull, generalized gamma, exponential, lognormal, loglogistic, and Gompertz. Among these distributions, the Weibull distribution provided the lowest Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) values for our full model (AIC = 384.05, BIC = 429.01), suggesting superior model fit. As such, this model is parameterized with a Weibull distribution:

$$\lambda_i = \rho\tau^{\rho-1} exp\left(\alpha + \underline{\beta}_1 \underline{X}_i\right) + \epsilon_i \tag{2}$$

where λ_i is the hazard function, $\rho\tau^{\rho-1}$ is the baseline hazard function, α, β, and ρ are parameters to be estimated and X_i is the vector of explanatory variables. The Weibull distribution allows the hazard rate to increase (a positive baseline hazard) or decrease (a negative baseline hazard) over time, providing flexibility in estimation. The resulting hazard ratios can be

[18]We estimated separate hazard models with and without the 21 ongoing projects; excluding the 21 ongoing projects did not meaningfully alter the PLA coefficients, and the significance levels remained the same.

Table 3. Contract Amount by Project Labor Agreement (PLA) Status (in quartiles)

Contract amount ($)	*PLA (%)*	*Non-PLA (%)*
500,000–869,000	9	29
877,619–1,512,777	28	24
1,535,895–3,130,000	32	23
3,166,500–74,309,532	31	23
Total	$n = 65$	$n = 248$

interpreted in the following way: ratios of 1 imply no changes in likelihood of completion in the following year; ratios greater than 1 imply higher likelihood of completion in the following year; and ratios less than 1 imply lower likelihood of completion in the following year. The empirical hazard model is:

$$(3) \quad \lambda i = \rho\tau^{\rho-1}(\alpha, PLA_i,\ Log\ Cost_i,\ Type_i,\ Non-urban_i,\ Start\ Year_i,\ End\ Year_i) + \epsilon_j$$

With respect to control variables, the first is *Log Cost*$_i$, the natural log of the total contract cost for all contracts on project *i*, according to the PWC-100; all else equal, more costly projects should require more time to complete. The primary purpose of the cost variable is to capture the complexity and size of the project. Total contract cost refers to the cost specified in the contract at the start of the project (i.e., it does not capture any cost changes that may have occurred throughout the project). As shown in Table 3, PLA projects tend to fall in the second, third, and fourth cost quartiles whereas non-PLAs are evenly distributed. The median non-PLA project cost was $1,491,539 and the median PLA project cost was $2,254,934. The variance inflation factor (VIF) for the main OLS model was 2.8, suggesting that collinearity was not an issue in our analyses; further, the correlation between the PLA and cost variables was only 0.13. We also provide the median contract amount by city, showing that Sacramento contracts fall approximately in the middle of contract costs in surrounding Sacramento County cities (see Table 4).

The next two variables control for project characteristics. Because PLAs are only mandated by the City of Sacramento, a city agency, and the Sacramento City Unified School District, a school agency, we include city agencies and school agencies in Sacramento County in this study to develop a comparative case. *Agency Type*$_i$ is an indicator with a value of 1 if the awarding body for project *i* was a city agency, and a value of 0 if the awarding body was a school district. *Project Type*$_i$ is an indicator with a value of 1 if project *i* was an alteration or repair project, and a value of 0 if it was a new construction project. After consulting with industry professionals and reading project descriptions for all 313 projects, we grouped projects into

Table 4. Median Contract Amount by City

City	*Median contract amount ($)*
Rio Linda	717,644
Carmichael	905,000
North Highlands	964,260
Loomis	1,094,511
Citrus Heights	1,257,024
Orangevale	1,302,500
Sacramento	1,492,768
Rancho Cordova	1,545,951
Galt	1,598,188
Elk Grove	1,659,775
Folsom	2,358,125
McCellan	2,679,158
Fair Oaks	3,025,000
All cities	1,465,077

Table 5. Number of Project by Construction Type, Project Type, and Project Labor Agreement (PLA) Status

Type	*PLA*	*Percentage of total PLA projects*	*Non-PLA*	*Percentage of total non-PLA projects*
Alteration	14	22	134	54
Construction	48	74	109	44
Repair	3	5	5	2
Total	**65**	**100**	**248**	**100**
Infrastructure	39	60	110	44
Building	26	40	138	56
Total	**65**	**100**	**248**	**100**

two categories of work based on definitions from Sacramento City Code: a "new construction" category and a "repair or remodel" category.[19] New construction projects were those in which the performed work involved erecting and building new structures, facilities, or infrastructure. In these cases, workers are building projects "from the ground up." Repair and alteration projects are those that involve modifying, restoring, or fixing existing structures or facilities, resolving mechanical issues or damage, or replacing fixtures or infrastructural components. Our data include 157 construction projects and 156 alteration or repair projects (see Table 5).

Construction Type$_i$ is an indicator with a value of 1 if project *i* was a road or other non-building infrastructure project (e.g., traffic light improvements, sewer replacement, trail enhancements, paving repairs) and a value of 0 if it was a building project (e.g., community center, roofing, shade structure).

[19]We use definitions from Sacramento City Code 3.60.010. We use the term "new construction" in lieu of the Sacramento City Code term "Public Projects."

Our sample comprises 164 building projects and 149 infrastructure projects. With respect to location, $Non\text{-}urban_i$ is an indicator with a value of 1 if project i took place in a non-urban area, and a value of 0 if it took place in an urban area. For this control, the population cutoff was 50,000; areas with populations above 50,000 were coded as urban, and areas with populations below 50,000 were coded as non-urban.[20] The data feature 258 urban projects and 55 non-urban projects. Accounting for potential differences in completion times between urban and non-urban projects, all else equal, we expect to find that non-urban projects take less time to complete than urban projects. We did not include separate city controls in our analysis; given the close geographic proximity of all projects in our data, the inclusion of the non-urban control should account for the most significant source of variation between the areas in which projects took place.

Last, $Start\ Year_i$ and $End\ Year_i$ are vectors of years in which project i commenced and ended, respectively. Year dummy variables are included to control for effects of the business cycle and construction labor market. Our study differs from some previous research by incorporating the year the project was started, rather than the year the project was awarded. We believe this provides a more accurate account, as work does not commence immediately after the project is awarded to the lowest bidder. We also include the year the project ended, to account for changes in the business cycle that may have occurred at some point during the project. For example, given that our data consisted primarily of projects that took place during the pandemic, we capture effects of supply-chain issues on these projects.

Results

The geographic distribution of projects, as well as the median length of time for projects by location, are presented in Table 6. As we expected, out of 313 total projects in the larger sample, 159 projects (approximately 51%) take place in the city of Sacramento, the largest population center. An additional 47 projects (approximately 15%) take place in Elk Grove, which is the second-largest population center in Sacramento County. While our data are majority-urban, the 55 non-urban projects included in the data still yield the ability to control for potential time to completion differences between urban and non-urban projects in the model.

Note that all 65 projects governed by a PLA took place in the city of Sacramento, which is to be expected given the mandates are through the City of Sacramento agency and the Sacramento City Unified School District. More non-PLA projects (90), however, took place in Sacramento. This disparity is because several school districts in Sacramento County did

[20]The California Code of Regulations title 14 § 15387 defines an urbanized area as "a central city or group of contiguous cities with a population of 50,000 or more."

Table 6. Number of Projects and Median Days, by City

City	*Number of projects*	*Percentage of total projects*	*Median days (completed)*
Carmichael	3	1.00	72
Citrus Heights	13	4.15	242
Elk Grove	47	15.02	249
Fair Oaks	6	1.92	416
Folsom	26	8.31	250
Galt	7	2.24	225
McClellan	2	0.64	356
North Highlands	25	7.99	212
Orangevale	7	2.24	275
Rancho Cordova	10	3.19	310
Rio Linda	8	2.56	226
Sacramento	159	50.80	258
Total	313	100	241

Notes: Median days (completed) is based on 292 completed projects.

not have an agency-wide PLA mandate but did have school locations in the city of Sacramento. The districts include Elk Grove Unified School District, Natomas Unified School District, San Juan Unified School District, and Twin Rivers Unified School District. Furthermore, eight city projects were exempt from the Sacramento City CWTA due to agreements with the city and various agencies, particularly the Sacramento County Water Agency.

Nonetheless, it is important to consider the possibility that effects of PLAs on time to completion may be capturing and reflecting effects specific to the city of Sacramento. According to Table 6, the median number of days for Sacramento projects (258) is slightly higher than but similar to the county-wide average (241). Additionally, the Sacramento median (258) is similar to the medians of two other key urban areas in the county: Elk Grove (249) and Folsom (250). This similarity suggests that Sacramento project timeliness does not initially seem to significantly differ from the county-wide average or from other urban areas in the county. We conducted supplemental analyses that compared times to completion for non-PLA projects in Sacramento with times to completion for non-PLA projects in other areas. If it is indeed the case that the effects are Sacramento-specific and not a result of PLAs, we should see significant differences in completion times between non-PLA projects in Sacramento and non-PLA projects in other cities. We estimate an OLS regression model with robust standard errors, with city as an indicator variable, and controlling for all variables discussed above. We assigned Sacramento (n = 148) as the reference group with a value of 0, and all other cities (n = 144) with a value of 1. Finally, we include only projects that did not have a PLA (n = 233). In all models, results were not

Table 7. Proportion of Completed Projects Began and Ended, by Year

Year	*Percentage began*	*Percentage ended*
2019	30.5	8.56
2020	31.2	29.10
2021	20.9	23.60
2022	17.5	28.80
2023		9.93
Total	100	100

statistically significant.[21] These results suggest that regional effects are not drivers of effects of PLAs on time to completion.

Table 7 presents the proportion of completed projects that began and ended, by year, for the years 2019–2023. All years in which projects commenced (2019–2022) are well-represented in the data, with at least 17% of projects beginning in each of those years. Aside from only 8.6% of projects ending in 2019 and approximately 10% of projects ending in 2023, at least 24% of projects ended in each of the other years. Fewer projects ended in 2023, as the search criteria for the sample were projects that were estimated to end in 2022. Thus, we did not expect to find a large proportion of projects completed in 2023.

OLS Model Results

We present OLS results in Table 8. The four models in the table have the following progression: model (1) is a baseline model with our independent variable of interest, *PLA*, and *Log Cost* as the lone control; model (2) adds the year controls; model (3) adds *Agency Type, Project Type*, and *Construction Type;* last, model (4) adds the *Non-urban* control. Across all three models that include controls for factors likely to impact project duration (models (2)–(4)), the presence of a PLA is associated with statistically significant 15 to 17.1 percentage point reductions in project duration.[22] That is, this study's results suggest that projects are completed 15 to 17.1% faster under PLAs, with findings significant at the 1% level.

In the baseline model (model (1)), PLAs are associated with a statistically significant 11.0 percentage point reduction in project duration. This effect increases in model (2) (which adds the year controls) and model (3)

[21]We conducted an additional supplemental analysis in which we replaced the non-urban area dummy in our main model with a Sacramento dummy; for this variable, a value of 1 indicated a project that took place in Sacramento, and a value of 0 indicated a non-Sacramento project. In this model, the coefficient on the Sacramento dummy was not statistically significant, while the PLA coefficient was still significant at the 1% level with a coefficient of –0.155, further suggesting that regional effects were not the drivers of PLA effects found in our study.

[22]To calculate these percentages, given that our dependent variable was log-transformed, we exponentiated the PLA coefficients. For example, in model (4), the percentage change is equal to exp(–0.162) – 1 = –0.15.

Table 8. OLS Models of the Effect of Project Labor Agreements on Time to Completion

Variables	*Model (1)*	*Model (2)*	*Model (3)*	*Model (4)*
Project labor agreement	–0.117***	–0.167***	–0.187***	–0.162***
	(0.035)	(0.025)	(0.020)	(0.026)
Log total project cost	0.469***	0.190***	0.194***	0.200***
	(0.034)	(0.039)	(0.045)	(0.039)
Start year: 2020		–0.675***	–0.681***	–0.669***
		(0.036)	(0.046)	(0.043)
End year: 2020		0.761***	0.771***	0.749***
		(0.073)	(0.071)	(0.066)
Start year: 2021		–1.322***	–1.312***	–1.304***
		(0.100)	(0.103)	(0.092)
End year: 2021		1.425***	1.423***	1.401***
		(0.051)	(0.071)	(0.048)
Start year: 2022		–2.097***	–2.065***	–2.074***
		(0.067)	(0.068)	(0.075)
End year: 2022		1.972***	1.950***	1.920***
		(0.078)	(0.085)	(0.056)
End year: 2023		2.713***	2.700***	2.680***
		(0.051)	(0.048)	(0.376)
Agency type			–0.139***	–0.169***
			(0.044)	(0.053)
Project type			0.077	0.066
			(0.065)	(0.070)
Construction type			0.003	–0.005
			(0.033)	(0.033)
Rural area				–0.186**
				(0.065)
Constant	–1.304**	2.205***	2.343***	2.482***
	(0.487)	(0.574)	(0.736)	(0.686)
N	292	292	292	292
R^2	0.355	0.650	0.654	0.660

Notes: Table displays estimated coefficients, followed by robust standard errors (clustered by city) in parentheses. OLS, ordinary least squares.
*Statistically significant at the 10% level; ** at the 5% level; *** at the 1% level.

(which adds *Agency Type, Project Type*, and *Construction Type*); model (2) results suggest a 15.4 percentage point reduction in project duration, and model (3) results suggest a 17.1 percentage point reduction. In model (4) (which adds the *Non-urban* control), this effect slightly decreases to a 15 percentage point reduction.[23] Nonetheless, all PLA coefficients have the expected signs and are statistically significant at the 1% level. Coefficients on controls generally have the expected signs. As expected, we find significantly positive associations (at the 1% level) between project cost and time to completion across all four models, reflecting the notion that more costly

[23]We also estimated model (4) using days as the dependent variable, rather than the natural log of days. Our results were robust to this change: With days as the dependent variable, PLAs are associated with construction projects being completed approximately 27 days faster, significant at the 1% level.

Table 9. Number of Completed Projects by City Agencies

Awarding agency	*Number of projects*	*Number of PLA projects*	*Percentage city projects*	*Percentage all projects*
City of Citrus Heights	6	0	8.22	2.05
City of Elk Grove	14	0	19.20	4.79
City of Folsom	11	0	15.10	3.77
City of Galt	1	0	1.37	0.34
City of Rancho Cordova	4	0	5.07	1.37
City of Sacramento	37	29	50.70	12.70
Total	73	29	100	100

Notes: At the time of data collection, nine city projects were still ongoing: one was awarded by Citrus Heights, one by Elk Grove, two by Sacramento, and five by Folsom. Two of these were PLAs (Sacramento) and seven were not. PLA, Project Labor Agreement.

projects require more time to complete. Additionally, in model (4), we find a positive relationship between Non-urban locations and timeliness: On average, projects taking place in non-urban locations are completed 17% faster than urban projects. This finding is in line with our expectation that non-urban projects take less time to complete than urban projects. We also note that while we expected a project type effect (e.g., road work being completed faster during the pandemic due to less traffic congestion), we did not find sufficient evidence of such an effect.

We also provide disaggregated data with regard to city and school projects, to analyze the effects of PLAs within these particular agency types. Tables 9 and 10 show the number of projects by awarding agency and PLA status for city agencies and school agencies, respectively. Though our models in Table 8 account for agency, project, and construction types, projects within an agency may provide an opportunity to compare especially similar projects. As shown in Table 9, city projects, which include projects such as erecting buildings, paving roads, or repairing sidewalks, to name a few, have a smaller sample size of 73, 8 of which were exempt from the city-wide PLA. This difference is partly attributable to stricter valuation threshold criteria resulting from the differing PLA thresholds established by the City of Sacramento ($1,000,000) and the Sacramento City Unified School District ($500,000).

The incorporation of city projects in our analysis is a novel contribution to the literature on the effects of PLAs on construction outcomes. Table 11 presents results for OLS models separated by agency type (i.e., school agencies and city agencies). As in the models presented in Table 8, the models in Table 11 include *PLA* as the independent variable, and controls for *Log Cost*, *Start Year* and *End Year*, *Project Type*, and *Construction Type*. In the isolated City model, we were not able to include controls for *Non-urban*, as all projects took place in an urban area. Results suggest that PLA projects awarded by city agencies are associated with a statistically significant 18.9 percentage point reduction in project duration, compared to non-PLA

Table 10. Number of Completed Projects by School Agencies

Awarding agency	*Number of projects*	*Number of PLA projects*	*Percentage school projects*	*Percentage all projects*
Elk Grove USD	52	0	23.70	17.80
Folsom Cordova USD	19	0	8.68	6.51
Galt Joint Union SD	6	0	2.74	2.05
Natomas USD	14	0	6.39	4.79
Sacramento City USD	30	30	13.70	10.30
San Juan USD	35	0	16.00	12.00
Twin Rivers USD	63	0	28.80	21.60
Total	219	30	100	100

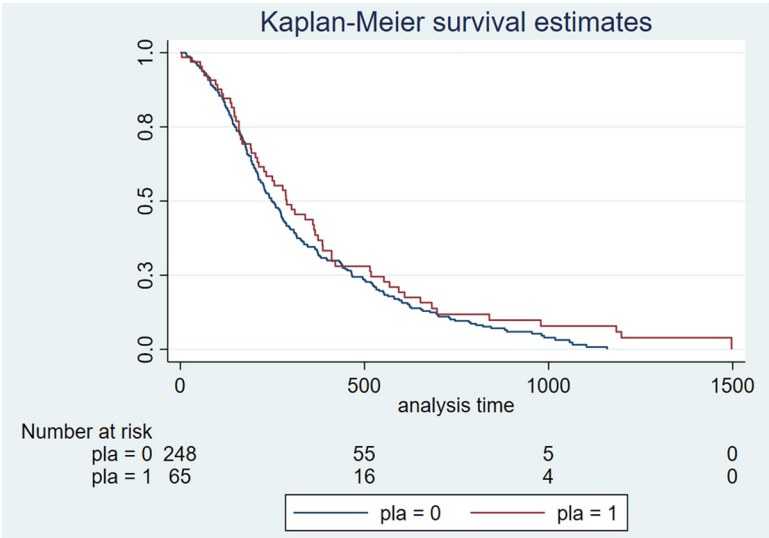
Notes: At the time of data collection, 12 school projects were still ongoing: three were awarded by Elk Grove USD, two by Twin Rivers USD, four by Sacramento City USD, one by Natomas USD, one by San Juan USD, and one by Folsom Cordova USD. Four of these were PLAs (Sacramento City USD) and eight were not. PLA, Project Labor Agreement; USD, Unified School District.

Table 11. OLS Models of the Effect of Project Labor Agreements on Time to Completion by Agency

Variables	*Model (1)* City	*Model (2)* School
Project labor agreement	–0.209**	–0.186***
	(0.074)	(0.042)
Log total project cost	0.165*	0.212***
	(0.066)	(0.029)
Start year: 2020	–0.443***	–0.788***
	(0.088)	(0.049)
End year: 2020	0.726**	0.791***
	(0.278)	(0.094)
Start year: 2021	–0.953***	–1.402***
	(0.136)	(0.096)
End year: 2021	1.454***	1.410***
	(0.329)	(0.109)
Start year: 2022	–2.331***	–2.054***
	(0.545)	(0.075)
End year: 2022	1.695**	1.999***
	(0.447)	(0.098)
End year: 2023	2.411***	2.811***
	(0.407)	(0.108)
Project type	0.292	0.028
	(0.180)	(0.064)
Construction type	0.104	0.027
	(0.159)	(0.034)
Rural area		–0.178**
		(0.062)
Constant	2.503**	1.993***
	(0.890)	(0.514)
N	73	219
R^2	0.667	0.688

Notes: Table displays estimated coefficients, followed by robust standard errors (clustered by city) in parentheses. OLS, ordinary least squares.
*Statistically significant at the 10% level; ** at the 5% level; *** at the 1% level.

Figure 2. Kaplan-Meier Survival Estimates of the Likelihood of Unfinished Projects by Project Labor Agreement (PLA) Status



Notes: Figure depicts the likelihood of projects remaining unfinished over time, or "surviving," by PLA status.

projects. This finding shows that cities, which may have a wider variety of project and construction types awarded by the agency than school districts, can still benefit from the presence of a PLA. Similarly, school district projects with a PLA were also associated with faster completion times. Among the 219 projects awarded by school agencies, PLAs are associated with a 17 percentage point reduction in project duration, significant at the 1% level. Although it is not appropriate to compare the PLA coefficient for school projects with the coefficient for city projects, the Table 11 results are consistent with our findings in Table 8 that PLAs are associated with reduced project duration.

Measuring Completion Likelihood

Figure 2 presents Kaplan-Meier survival estimates, which compare the likelihoods of survival over time for PLA and non-PLA projects. With the failure event defined as the completion of a project, survival involves this event not occurring—in this case, a construction project not being completed during the time frame of this study. These estimates then compare the likelihood of PLA and non-PLA projects remaining unfinished over time. Because these estimates do not include any controls, they can be interpreted as an initial baseline comparison by PLA status. While both types of projects, as expected, are more likely to be completed over time, the Kaplan-Meier estimates suggest that PLA projects may take more time to complete than non-PLA projects. Given the lack of controls in these

Table 12. Hazard Rate Models for Likelihood of Project Completion

Variables	*Model (1)* All	*Model (2)* City	*Model (3)* School
Project labor agreement	1.430***	1.408***	1.757***
	(0.094)	(0.076)	(0.116)
Log total project cost	0.679***	0.633***	0.647***
	(0.019)	(0.117)	(0.017)
Start year: 2020	6.414***	3.025***	8.787***
	(0.786)	(0.851)	(1.626)
End year: 2020	0.118***	0.156**	0.110***
	(0.014)	(0.131)	(0.025)
Start year: 2021	33.568***	12.401***	44.076***
	(5.738)	(5.837)	(7.175)
End year: 2021	0.017***	0.018***	0.015***
	(0.003)	(0.020)	(0.004)
Start year: 2022	177.64***	176.29***	221.96***
	(38.61)	(126.81)	(48.11)
End year: 2022	0.004***	0.007***	0.004***
	(0.001)	(0.011)	(0.001)
End year: 2023	0.000***	0.001***	0.000***
	(0.000)	(0.001)	(0.000)
Project type	0.805**	0.440***	0.896
	(0.082)	(0.081)	(0.107)
Construction type	1.000	0.715	0.941
	(0.108)	(0.246)	(0.098)
Rural area	0.801*	4.142***	0.791*
	(0.103)	(2.112)	(0.096)
Agency type	0.554***		
	(0.057)		
Constant	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)
N	313	82	231
ρ	2.850	3.233	2.881

Notes: Table displays estimated coefficients, followed by robust standard errors (clustered by city) in parentheses.
*Statistically significant at the 10% level; ** at the 5% level; *** at the 1% level.

estimates, it is conceivable that non-PLA projects may initially seem more likely to be completed, since PLAs are typically found on larger, more complex projects. However, hazard rate models are needed to determine whether this difference holds after controlling for a variety of factors.

We present our hazard rate model results in Table 12, with the following progression: Model (1) is the full model with our independent variable of interest, *PLA*, and all controls; model (2) focuses on projects awarded by city agencies; and model (3) focuses on projects awarded by school agencies. As mentioned previously, these models allow us to account for the right-censoring problem caused by construction projects in the data not yet completed at the time of data collection. Across all models, as we expected, the sign of the shape parameter, ρ—the estimate of duration dependence—is positive, suggesting that the likelihood that a project is

completed increases over time and the estimated hazard function is exhibiting positive duration dependence. In model (1), with a PLA hazard ratio of 1.43, results suggest that PLA projects are 43.0% more likely to be completed in the following year than non-PLA projects, which is statistically significant at the 1% level. Alongside the OLS results, our hazard rate model results suggest that construction projects governed by PLAs are completed significantly faster than non-PLA projects.

In line with our OLS results, models (2) and (3) of Table 12 suggest that projects awarded by city and school agencies governed by PLAs feature significantly higher likelihoods of completion in the following year than non-PLA projects, suggesting faster completion. For city projects, PLA projects are 40.8% more likely to be completed in the following year than non-PLA projects; for school projects, PLA projects are 75.7% more likely to be completed in the next year than non-PLA projects, in line with OLS results that suggested faster completion under PLAs for projects awarded by both school and city agencies. Both of these hazard ratios are significant at the 1% level. As was the case with respect to timeliness, across all three models, coefficients on controls are as expected. We find hazard ratios significantly lower than 1 for project costs across all models, reflecting the notion that more costly projects require more time to complete.

Discussion and Conclusions

Former President Biden's Infrastructure Investments and Jobs Act, coupled with Executive Order 14063 that mandates the use of PLAs on federal agency projects at or over $35 million in total costs and California's PLA mandate on major state projects, motivate greater academic attention to impacts of PLAs on construction outcomes. Though the effects of PLAs are contested among scholars and practitioners alike, our findings provide a foundation for future research to explore the relationship between PLAs and project time to completion. We find that in the case of city and public school projects in Sacramento County over the years 2019 through 2023, those built with project labor agreements were associated with a reduction in project duration of 15 to 17 percentage points. Additionally, our hazard rate model results suggest that PLA projects are 43% more likely to be completed in the following year than non-PLA projects, providing further evidence that PLA projects are completed faster than non-PLA projects. These findings support advocates' claims that PLAs may protect construction contractors and owners from risk and promote timely completion of projects by ensuring timely access to skilled labor and harmonizing work scheduling provisions across various construction trades.

These findings are particularly pertinent in the context of the pandemic. As did firms in many other industries, contractors had significant difficulties finding workers during the pandemic. PLAs were adopted and designed to ensure a steady supply of skilled labor on construction projects by reducing

risk and harmonizing collective bargaining agreements across many crafts—and by preventing strikes and lockouts. This detail, alongside the role of union hiring halls in matching workers to jobs, may make PLAs particularly well-suited to address labor shortages during economic downturns and emergency situations such as the pandemic. Our sample was primarily composed of projects that took place during the pandemic, which suggests that PLAs may have ensured more consistent access to skilled labor for contractors on PLA projects, thereby shortening completion timelines during this particular crisis. Further research may replicate our methodologies to identify generalizability to a more normal and expansionary period.

Though the PLA literature is limited, our findings, as well as peer-reviewed results on bid competition (Philips and Waitzman 2021) and construction costs (e.g., Belman et al. 2010; Waddoups and May 2014; Philips and Waitzman 2021), present a clearer picture. Research shows that although PLA projects are generally larger and more complex than non-PLA projects (Belman et al. 2010), PLAs can promote faster completion of projects and do not significantly impact project costs or the number of bidders (Philips and Waitzman 2021). Additionally, our findings suggest the potential for reduced cost, as labor time needed to complete the work on PLA projects is shorter than non-PLA projects; however, this study does not speak to that issue directly. We hope our study stimulates research that explores how the relationship between PLAs and timeliness may be connected to cost impacts of PLAs. Rather than analyzing bid cost and final cost—which will likely be higher on PLA projects given their purpose on high-cost and complex projects—future research may benefit from an analysis of percentage cost differences between initial and final costs for PLA versus non-PLA projects.

Ultimately, our results suggest that PLAs may provide benefits to the public with respect to time to completion. Shorter project timelines may lessen the cost of a project associated with both labor and the costs of shutting down and restarting. Moreover, our study suggests that PLA projects are completed more quickly than comparable non-PLA projects, which has many social and economic implications. As a result of PLAs, Sacramento taxpayers may have more immediate access to water treatment plant improvements, and be able to send their children to schools with working air conditioning and new playgrounds faster than cities without PLAs. The economic impact of quicker repairs to public infrastructure is especially significant. For example, delays in road repairs not only increase the cost of the public project but likely lead to productivity losses caused by increased transportation times for workers and goods. Ultimately, policies regulating public works construction and workforce development can have profound, far-reaching impacts on a community's social and economic well-being. Economic research in this area would benefit from extending analysis beyond individual projects to include the broader effects of public works construction and workforce development policies on communities.

PLAs also support the growth of California apprenticeship programs and trained construction workers to meet the state's evolving infrastructure needs. California recently allocated $3.1 billion for transportation infrastructure, $1.8 billion of which came from the federal Infrastructure Investments and Jobs Act (Caltrans 2023), highlighting the urgent need to develop a skilled construction workforce who can fill demand in an already tight labor market. In California, joint apprenticeship programs, for which training fund contributions are made under PLAs, are responsible for 92% of apprenticeship training in the state overall and 97% of female construction apprentices relative to "employer only" programs (Calamuci 2020). Workers in California benefit from these joint construction apprenticeship programs that provide pathways to the middle class, and the ability to start a career debt-free.

Ours is the first academic study to examine the relationship between the time to completion and PLAs attached to publicly funded projects and comprises the largest sample of projects in an academic study of PLAs to date.[24] In addition to the breadth of our study, our research incorporates non-school projects such as roads and sidewalks, as well as controls for both the start and end year of construction. The year a project started is a more accurate measure than the year the project was awarded because work does not commence immediately after the project is awarded to the lowest bidder. Additionally, in controlling for the year the project ended, we account for changes in the business cycle that may have occurred at some point during the project, such as supply-chain issues that may have occurred for projects that took place during the pandemic.

This study is not without limitations. First, though focusing on one geographic region is not unprecedented among PLA research studies (e.g., Belman et al. 2007), the generalizability of our findings is not entirely clear given that all projects in our sample are located in the same county. Focusing this analysis on a single county yields the ability to improve controls for location and better control for variance in PLA outcomes that could be caused by regional differences. Ultimately, focusing on one geographical region—which still includes multiple cities and agencies and provides a larger sample size than any study of its kind to date—allows for a rich comparative study.

Second, because of data limitations, we are unable to control whether a project, regardless of PLA status, included union or non-union contractors. As a result, we cannot determine how much, if any, of the PLA effects on project duration found in this study can be attributed to the type of contractor overseeing the project. With a recent report stating that union labor contributes to higher productivity (McFadden et al. 2022), it may also be the case that projects with union contractors, regardless of PLA status, are

[24]While our study features the largest sample overall, it should be noted that Philips and Waitzman (2021) included a larger sample of school projects (263) than our study.

completed faster; we acknowledge our inability to control for this possibility. We encourage future research to build on our work by examining the degree to which supervision by union contractors impacts construction project timeliness and how this relates to effects of PLAs. Disentangling the effects of union contractor supervision from the effects of PLAs would provide greater clarity on this issue. Although we cannot control if a project included union or non-union contractors, we know California represents the 10th most unionized construction sector. Sacramento County, however, is not a relatively unionized part of California. Considering California's relatively high unionization rate, it is possible the implementation and operation of PLAs may differ in areas with fewer union contractors.

Third, additional factors we have not examined may contribute to time to completion, including the cost of late penalties (which varies depending on the valuation and complexity of a project), a contractor's desire to continue working with a particular agency and thus perform work quickly, project characteristics that may impact permitting processes beyond those already captured in models, and differences that may result from the personnel assigned to plan checks, inspections, and approvals. While we cannot control for the individual inspector assigned to each project, our findings suggest that workers may be able to move through the inspection process faster on a PLA project than a non-PLA project. Further research may consider these more subjective and particular factors, and may also assess whether a project was on time or late, rather than when the project is brought to market as the current study assesses, and any of the cost implications of timeliness.

Last, as noted in the results, the findings presented in Table 9 are limited by the fact that our sample of projects awarded by city agencies (73) is small in size, especially when compared to our sample of school projects (219). The smaller sample size may be slightly inflating the statistically significant coefficient for PLA projects awarded by city agencies. Nevertheless, because of issues with data availability, prior PLA research is almost exclusively limited to the construction of public schools and community colleges (see Table l). Alongside our novel contribution as the first study to examine the impact of PLAs on time to completion, we contribute further to the literature by examining these impacts across multiple types of construction projects awarded by both school and city agencies.

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