Procurement and Infrastructure Costs

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July 21, 2023

Abstract

Infrastructure costs in the United States are high and rising. The procurement process is one potential cost driver. In this paper we conduct a survey of procurement practices across the 50 states. We survey both employees at each state department of transportation (DOT) and the road builders that win contracts to build and maintain roads. With this survey we are able to create a new dataset of procurement rules and practices across the U.S. and understand what actors on the ground think drive costs. We then assemble a new dataset of *project-level* infrastructure costs. We correlate the survey practices with our new, detailed data on costs. We find that two important inputs in the procurement process appear to particularly drive costs: (1) the *capacity* of the DOT procuring the project and (2) the lack of *competition* in the market for government construction contracts.

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1 Introduction

The United States spends a large amount on infrastructure costs: for example, state and local governments spent $187 billion on highways alone in 2018. Yet there is a growing concern that the quality of infrastructure is declining (American Society of Civil Engineers, 2017; US Census Bureau, 2018). Recent work by Brooks and Liscow (2023) documents road building costs in the U.S., finding that spending per mile tripled from the 1960s to 1980s. And today, US infrastructure construction costs are very high by international standards.[1] Not only are costs high and increasing, but there seems to be substantial heterogeneity in the cost per mile and road quality across states.

One potentially important, but previously untestable, hypothesis, is that procurement practices explain differences in infrastructure costs across states. Public procurement accounts for 25% of all government expenditures in the U.S., making efficient practices all the more important (Organisation for Economic Co-operation and Development, 2017). Infrastructure is a good setting to study procurement; every federally funded road building and resurfacing project goes through a procurement process, usually an auction. Typically the state government does not build roads; rather, it disburses and oversees contracts that are completed by firms in the private sector.

A vast literature shows, theoretically and empirically, that the design and implementation of procurement auctions have implications for total cost. While the existing literature provides evidence on specific programs in specific states for which rich data exists, there is no comprehensive dataset on highway procurement practices across states. As a result, the literature has major blind spots on areas that could be very important to infrastructure costs, but lack data or useful within-state variation for any empirical design.

We produce three new datasets to help fill this gap. First, we conduct a 50-state survey of state Department of Transportation (DOT) highway procurement. This project collects data on the procurement process to resurface highways in each state, using a survey based on the World Bank's Doing Business Procurement Module (Bosio, Djankov, Glaeser and Shleifer, 2022). We survey two groups in each state who have complementary knowledge about state procurement: procurement officials at each DOT and contractors (i.e., road builders and engineers). The survey focuses on potential cost drivers in the procurement process, and we can learn where there is agreement in practices across states and what the experts on the ground think drives costs.

Second, to study procurement cost drivers, we need detailed data on the realized costs of the state DOT projects. To this end, we create a new dataset on *project-level* costs for each state. We collect

[1] NYU Transit Costs Project (https://transitcosts.com/executive_summary/).

this data state-by-state. While some states make this sort of data publicly available, others we obtain via public records requests. Then, we match the contract data with project plans and bid lettings, in order to create a cost per mile measure that is comparable across states.

Third, we assemble administrative data on the construction industry that completes projects and the public sector industry that manages projects. This also includes non-procurement cost drivers to use as control variables, such as weather and population density. We show that the cost data we collect is correlated with observables that should drive costs (weather, road usage, labor costs), as well as the cost drivers that were introduced in the survey (DOT capacity and competition).[2]

With the first dataset, we can produce summary statistics on what experts think is driving costs. With the three datasets together, we can correlate specific procurement practices with cross-state data on resurfacing costs, of course with the acknowledgment that correlation is not causation. We start with the experts. Here, the evidence points to two broad patterns:

1. **State DOTs have limited capacity.** In the survey, there is broad agreement that state DOTs are understaffed and that reliance on consultants drives up costs. If the state DOT is understaffed they need to outsource a lot of work to consultants, which are expensive and do not necessarily have the same incentives as career DOT employees. Free responses in the survey attribute the lack of details in project plans to consultants. When there is not enough specificity in the plans the risk to the contractor increases, increasing bids. Moreover, when the scope of the project changes this initiates a costly and time consuming renegotiation process. Survey respondents agree that such changes are a major contributor to costs. We confirm that the state DOT workforce has been shrinking with administrative data on public sector employment.

2. **There is not enough competition.** Lack of competition is a complaint from procurement officials, although there are not many efforts to do outreach and increase the bidder pool. This is also a complaint from contractors, but at the subcontractor level. We show, with external data on the highway construction industry, that concentration in the industry seems to be rising. Most states have experienced a loss of construction firms, and an increase in size of the remaining firms, in the last 10 years.

Given the stated cost drivers from the survey respondents and confirmation of the two patterns using external data, we proceed to the correlations with realized costs. Both procurement practices and costs vary widely across states. But most state-level procurement practices do not correlate with

[2]Publicly available data on resurfacing costs from the Federal Highway Administration does not correlate well with observable cost drivers like weather or road quality. We compare this dataset to our own in Appendix A.2.

realized costs. But the correlations that emerge are consistent with the cost drivers that the experts identify.

First, we find evidence that state capacity correlates inversely with costs in a several ways. States with (perceived) higher quality DOT employees have lower costs. A state with a neutral rating has almost 30% higher costs per mile than one that rates the DOT employees as "moderately high quality", all else equal. Consistent with the capacity hypothesis, states that flag concerns about consultant costs have higher costs. States where contractors and procurement officials expect more change orders have significantly higher costs. Frequent change orders could directly lead to higher costs through delays and costly renegotiation; they could also be a downstream symptom of poor administrative capacity at a state DOT—many contractors reference poor-quality project plans made by third-party consultants. Moreover, when we measure capacity using external data we show that states with higher DOT capacity have lower infrastructure costs. A one standard deviation increase in capacity is correlated with 16% lower costs.[3]

We also find compelling evidence of the relationship between competition and costs. Using our project-level cost data, we find that an additional bidder on a project is associated with 8.3% lower costs, or a savings of approximately $30,000 per lane-mile ($460,000 for the average project). In the survey data, we find that states that do outreach to increase the bidder pool have significantly lower costs, highlighting both the importance of competition and the role the DOT can play in order to increase competition. A one standard deviation (12 percentage point) increase in bidder outreach is correlated with a 17.6% decrease in costs. At the mean, this translates to a decrease in costs of $65,000 per lane-mile and $1 million at the project level. Lastly, we find that limits on the amount of work that can be subcontracted is positively correlated with costs. High own-work thresholds can decrease competition by limiting the number of firms that can complete the project without additional subcontracting.

This paper contributes to a burgeoning literature on the U.S. construction industry, and infrastructure construction in particular. Goolsbee and Syverson (2023) have documented a large and long decline in construction sector productivity. Kroft, Luo, Mogstad and Setzler (2022) show that construction firms have considerable market power: in both the labor and the product market. On the infrastructure side, Brooks and Liscow (2023) find that increases in costs in road building in the later part of the 20th century were driven by citizen voice, which delay the process, instead of increases in materials or labor costs. Mehrotra, Turner and Uribe (2021) find that input prices are

[3]Here, the capacity measure is from administrative data on public sector Highways employment from the census (US Census Bureau, 1997-2021).

more important for resurfacing. This paper adds one important piece to the understanding of the interaction between the DOT and the private sector: the procurement process.

Our finding that procurement costs are highly correlated with DOT capacity is consistent with a literature on bureaucratic competence and capacity, both in the United States and abroad. Best, Hjort and Szakonyi (Forthcoming) find that about 20% of variation in prices in procurement auctions for goods in Russia can be attributed to the individual procurement officers, and another 20% to the procuring organization. In the U.S. setting, Decarolis, Giuffrida, Iossa, Mollisi and Spagnolo (2020) study bureaucratic competence across federal agencies, and finds that increases in competence, as measured by internal agency surveys, leads to less delays, less renegotiation, and lower costs in federal procurement. Warren (2014) finds that retirement induced increases in procurement officer workload, also in the federal government, increases the risk of renegotiation and contract costs. A striking decrease in state DOT employment over the last 20 years, and especially in the wake of the Great Recession, may have certainly contributed to rising costs (US Census Bureau, 1997-2021).

2 Background on State DOT Procurement

In this section we provide a brief primer on the state DOT procurement process. We proceed chronologically, and highlight which practices at each stage of the procurement process have the potential to affect final highway construction costs. The hypotheses are mostly from the IO literature, which includes many specific case studies from a handful of states. However, the survey will also allow us to highlight cost drivers that have not been studied much in existing literature. For example, we can ask about how often the state DOT employs consultants, which is often mentioned in conversations with practitioners as a potential costly practice (Levin and Tadelis, 2010).

Outside of the procurement process, we also ask about DOT capacity and quality, to speak to the ability of the state to run an efficient procurement system and oversee road maintenance and construction. On the contractor side, we ask about firm size and experience, as well as their knowledge of their competitors and their investments in cost reductions.

2.1 Pre-bidding

In the first stage, pre-bidding, the procuring entity (which is the state DOT here) assesses its procurement needs and budget. The DOT decides which projects to complete and the scope of each project (e.g., a project for 30 miles of road vs. three separate projects for 10 miles), and the state's engineer estimates the cost of each project. State DOTs often plan highway construction projects 4 years or more in advance to conform with federal regulations.

Contractors' bids are higher when they are capacity constrained.

If there are only a few eligible contractors for a large complicated project, and these firms have capacity constraints, both the timing of projects and the size of the job have the potential to reduce the pool of potential bidders, reducing competition and driving up final procurement costs (Best, Hjort and Szakonyi, Forthcoming; Jofre-Bonet and Pesendorfer, 2003).

For instance, timing procurement with aggregate demand shocks could take advantage of slack construction firm resources, although government stimulus may invert this effect. An examination of the 2009 ARRA stimulus package on highway construction found that the government paid prices that were 6.2% higher "due to the effect of stimulus projects on firms' backlogs" (Balat, 2012). Due to capacity constraints, the firm that has already committed to an ongoing project will have to pay overtime wages or rent additional workers; competitors may increase their bids if they know their rivals are constrained.

2.2 Bidding: Announcing the Project and Collecting Bids

In the second stage, bidding, the DOT determines the procurement method, the information made public for the project, and how the bids will be collected. The procurement method has a direct effect on costs, as different auction designs correspond to different optimal bidding strategies (Milgrom and Weber, 1982). However, given our focus on road resurfacing, there is no variation in the actual auction design; we know all states use low-bid (first price) auctions.[4] However, the states do have discretion on where they post the project, whether they advertise it, and what information they include.

Providing detailed and accurate information on project plans reduces final costs.

There is no federal mandate dictating how much information a state DOT needs to provide to bidders. However, there is evidence that providing more information to bidders on the specifics of the project and engineer's estimate can reduce costs (De Silva, Dunne, Kankanamge and Kosmopoulou, 2008). In effect, providing more detailed plans to bidders reduces uncertainty on construction costs which will result in realized costs being closer to the winning bid. The accuracy of these plans is also important: conversations with practitioners indicate to us that incomplete or incorrect plans can delay project completion or lead to costly renegotiation.

[4] This is typical for road resurfacing and building projects that use federal funds, which are the focus of our survey. More complicated projects might be evaluated on price and quality. There is evidence that evaluating bids on quality, not only price, provides incentives for faster delivery (Lewis and Bajari, 2011).

Providing detailed information on competing bidders can increase costs.

It is also possible that more information can increase costs, when this information facilitates collusion. For example, in Kentucky, the DOT made the names of firms that purchased bid proposals public the Friday before bids were due. This allowed firms to know if anyone was eligible to bid against them before submitting their actual bid (Barrus and Scott, 2020). The authors suggest that "the threat of even a second potential bidder in an auction [would lower] the winning bid by over ten percent," and that reforming the two-step procurement process, with its opportunity for gaming bids, could reduce costs for highway construction in Kentucky.

Efforts to increase the bidder pool can decrease costs.

Advertising the project and doing outreach to potential bidders can have substantial effects on the level of entry (Krasnokutskaya and Seim, 2011; Levin and Smith, 1994) and the ability of incumbent bidders to collude (Bajari and Ye, 2003; Clark, Coviello, Gauthier and Shneyerov, 2018; Porter and Zona, 1993). It is well-established in the auction literature that increasing competition can reduce costs, and efforts in St. Paul, Minnesota has shown bidder outreach can achieve this effect (Government Performance Lab, 2016; Liebman and Azemati, 2016).

The DOT's level of outreach is not specific to the auction design, so it is not the focus of much of the IO procurement auction literature. An important contribution of our survey approach is to collect data on these procurement practices which may not be codified in state regulations but have the potential to substantially affect costs.

2.3 Bidding: Evaluating Bids and Awarding Contracts

After the bids are collected, the bids are evaluated and the contract is awarded.

Strict criteria to evaluate bids have the potential to decrease costs.

The common legislative requirement is to award highway construction using a low-bid system. However, procurement officials are generally wary of extremely low bids. These could be the result of the bidders attempting to win the contract for a low price, expecting to renegotiate a higher price at a later date. These could also be the result of an inexperienced bidder, not realizing what actual costs will be: "[U]nrealistically low bid[s], while appearing to be a real bargain, may in fact result from the bidder's lack of competence to successfully complete the given project" (National Academies of Sciences, Engineering, and Medicine, 2006). The procurement office can police "abnormally low" bids by establishing a criterion to identify them, and then throwing out bids that are flagged as abnormally low or "mathematically unbalanced" (i.e, when a bid is unrealistic in its cost structure).

Strict criteria to evaluate bids have the potential to increase costs if overly burdensome.

During the bid screening process the procuring entity can exclude bids for other types of errors besides abnormally low bids. If the bidding process is too complicated it creates the possibility for bidders to make small technical mistakes that disqualify otherwise qualified bids (Best, Hjort and Szakonyi, Forthcoming). Trivial reasons to exclude bids in the bid screening process will artificially reduce competition, and increase costs.

2.4 Execution of the Contract

Execution concerns everything that happens in the period between the commencement of work and when the project is completed. This includes delays, contract renegotiation, payment, and inspection of the final works.

Delays increase costs.

This is a well-known fact in the literature. Delays increase total project costs, and incur costs to commuters who would like to travel on the road that is being serviced. What are not as well established are the degree to which delays vary across states and the source of the delays. Our survey asks about the frequency of delays, the usual causes of delays, and about two specific processes that can cause delays: obtaining regulations and permits for work, and renegotiating the contract.[5] Recent work in the Kenyan setting show that more stringent certification and inspection requirements required by the World Bank led to substantial delays (Wolfram, Miguel, Hsu and Berkouwer, 2023).

The renegotiation process causes realized costs to exceed winning bids.

Incomplete contracts can create a costly renegotiation process, which bidders might take advantage of when submitting bids in the bidding stage (Lewis and Bajari, 2014; Ryan, 2020). Completing any negotiation or change orders quickly will reduce delays, as discussed above. Beyond delays, the ability to renegotiate on costs can affect bidder strategy. Therefore, anything that the DOT does to constrain the renegotiation process can have an impact on costs.

3 Data Collection

We embark on two ambitious data collection efforts to study the relationship between DOT procurement practices and realized costs. First, we design and implement a survey to collect data on

[5] After the passage of Resource Conservation and Recovery Act and subsequent regulation, Alabama DOT accepted bids for a project involving lead paint removal. One company that was aware of the regulations submitted a bid three times the size of a contractor that was unaware of the regulation changes (Tarrer and Boylan, 1995).

procurement rules and practices from procurement officials and local contractors in each state. Second, we assemble project-level cost data on state road resurfacing projects via public records requests from state DOTs.

3.1 Survey Methodology

We follow the general framework of the World Bank Doing Business "Contracting with the Government" survey, which collected data on the procurement laws and practices of 187 countries (Bosio, Djankov, Glaeser and Shleifer, 2022). In the Doing Business project, each survey respondent is given a "case study," which is an example road resurfacing project. They are then asked questions about the rules and practices that would dictate the procurement process of the project. Our case study and a description of the survey follows. The full survey is found in the Appendix.

3.1.1 Case Study

The case study describes a standard project contracted by a state DOT. The project entails resurfacing 5 miles of a flat two-lane road that is part of the National Highway System (but is not an Interstate). The road would extend from the outskirts of a medium sized city into the surrounding rural area, with an asphalt overlay of 1 inch. The estimated value of the contract is between $1 to $5 million.

We chose to focus on resurfacing because, although highway-building projects can be more complicated and involve more discretion (which would be interesting from a procurement perspective), many states are not building new highways. In fact, in between 2004 and 2014 the rehabilitation of roads increased from 47% to 72% of total capital outlays on state and local highway spending. This means that at the same time, road expansion and new construction fell from 53% to 28% of outlays. Therefore, because we are interested in what drives costs for state DOTs broadly, we focus our case study on the most common type of project.

3.1.2 Survey

The survey questions are organized roughly chronologically over the course of a typical project, and, like the World Bank survey, are designed to collect information on transparency, competition, limits to exclusion, and the integrity of the contract, all which have the potential to affect costs. As discussed in Section 2, these issues may arise in different points along the procurement process, and have direct bearing on the final cost of procurement. Questions on the public availability of documents such as the engineer's estimate, number of registered bidders, and details of past contracts all concern transparency. Questions on outreach, advertising, or other attempts to increase participation are intended to collect information on competition. Questions on the bidder pre-qualification and bid screening focus on the limits to exclusion in the procurement process. Lastly, questions on renegotiation, changes in the project details, and payments all concern the integrity of the contract. Throughout we ask questions about the time it takes to get from one stage of the procurement process to the next. We depart from the World Bank survey in asking free form questions about what the procurement officials and bidders think drive costs, and asking about the capacity of the state DOT and the competitive environment for the bidders.

3.1.3 Distribution

The surveys for the procurement officers and the road builders and engineers (also known as contractors) are slightly different. This is sometimes as simple as question phrasing. For the contractor we ask, "To the best of your knowledge, how often does the agency do outreach to increase the bidder pool for highway construction projects?" To the procurement officer, who should know about the universe of projects, we simply ask "How often does the agency do outreach to increase the bidder pool for highway construction projects?" However, there are also questions that are group-specific. For example, we only ask the contractors about their expectations of the level of competition. Therefore, we launch the survey separately for procurement officers and for contractors. The sample and survey distribution method for each group is as follows.

Procurement Officers

We collect contact emails for procurement officers from two sources: a trade association and the state DOT websites. The American Association of State Highway and Transportation Officials (AASHTO) is a trade association; we utilize the contact lists for the Maintenance, Construction, Design, Materials, and Planning committees. We supplement these emails with contact information on each state's public DOT websites.

We directly email the survey to these contact emails. Respondents follow a link to complete the survey via Qualtrics.[6]

Contractors

We also collect contact emails for the contractors (road builders and engineers) from contractor trade associations and each state's public DOT website. Here we use public announcements of winning bidders or lists of pre-qualified firms. The contact information sometimes includes only the firm name

[6]Survey distribution started on April 19, 2022, and ended on September 1, 2022.

and phone number, so we then google the firm to get the email address. As with the procurement officers, we email the contractors directly.[7]

Sample

Appendix Figure B.1 shows the geographic distribution of survey respondents. We have 192 survey responses from procurement officials in 50 states plus the District of Columbia (a response rate of about 15%). We summarize the survey responses at the state level, averaging responses within each state. On average, we have 2.5 responses per state, though this ranges from 7 responses in Utah, to only 1 in 12 states. On the contractor side, we have 212 survey responses from 47 "primary" states. The firms we survey often operate in many states, but we ask them to consider their primary state of operation while answering the survey. On average we have 4.5 responses per state, though this ranges from 20 responses in Texas, to only 1 in 8 states.

3.2 Project-Level Data on Costs

We collect project-level cost data by requesting administrative data from each state DOT. Unfortunately, there was no such comprehensive dataset already; the federal DOT does not require states to report project-level costs on federally funded projects.[8] Most research on the topic uses aggregate (state level) spending from the Federal Highway Administration (FHWA), but we need detailed project-level data in order to facilitate a comparison of similar projects across states.

We compare our data with the FHWA data in Appendix A.2, and find that our data correlate with well established cost drivers (i.e. weather, road quality), while the FHWA data does not. The FHWA data is submitted by the states, and each state can determine how to account for projects over categories and time. Therefore there are concerns over different norms across states in categorization of work-type and multi-year projects. The comparison bolsters our confidence that the project-level cost data is the right dataset for our purposes and will be a useful resource for future research.

We have project-level cost data from all 50 states. These data generally include the winning bid for the contract, a brief description of the project (or at least an ID we can link to the bid letting or project plans), the final cost of the project, the award date, and the completion date. We have also obtained data on the size of each project, allowing us to compare cost per mile across projects.[9]

To facilitate cost comparisons across projects and states, we construct a sub-sample of projects meeting a predetermined criteria. Our goal is to create a sample of projects that are similar to the

[7]Survey distribution started on June 9th, 2022, and ended on October 27, 2022.

[8]An exception is for projects funded in the ARRA, but this is 10 years before the period of interest.

[9]Some states include mileage in the data they provide, for many others we use the bid lettings or project plans that are associated with the specific project. Specifically we calculate the lane-mileage for each project, which takes into account both the length and width of the project.

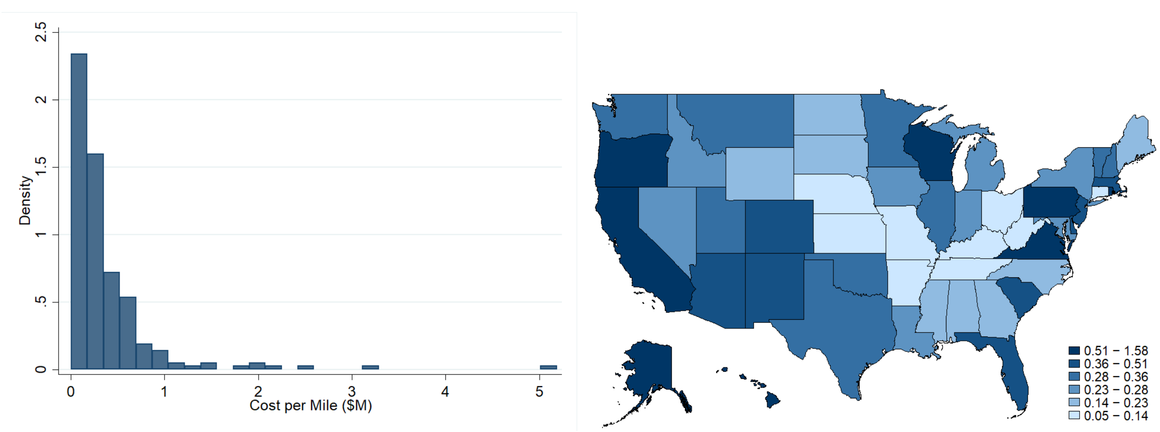
project described in the survey case study. Specifically, we randomly select 5 projects from each state that satisfy the following:

- Classified as "resurfacing",
- Started in 2018 or 2019,
- Project length between 1 and 20 miles, and
- State or U.S. highway (non-interstate) project.

Along with facilitating more direct comparisons, focusing on a smaller number of projects in the sub-sample allows us to gather more detailed information about the nature of work for each project. We are also able to fill in fields that are missing in the larger datasets, through examining the individual bid lettings and project plans.

Figure 1 shows the distribution of cost per mile at the project level, and the average cost per mile at the state level.[10] The majority of projects in the sub-sample (95%) cost under $1 million per mile; average cost is about $368,000 per mile, and the median is $226,000/mile. However, there is substantial variation in average costs across states. For example, cost per mile is twice as expensive in South Carolina than in the neighboring state of Georgia, at $376,000 and $189,000/mile respectively. Appendix Figure A.3 shows that the majority of the sub-sample contracts have a contract size of under $5 million, as was specified in the case study.[11]

Figure 1: Cost Data Sample



(a) Project-Level

(b) State-Level

Notes: The figure on the left shows the histogram of project-level resurfacing costs per lane-mile. The sample is 250 projects: 5 projects per state. The figure on the right takes the average of project costs at the state level. Data collected by the authors.

[10] Our measure of cost per mile is the total cost of the project divided by the lane-mileage of the project.

[11] Appendix A.1 provides more details on data collection and descriptive statistics.

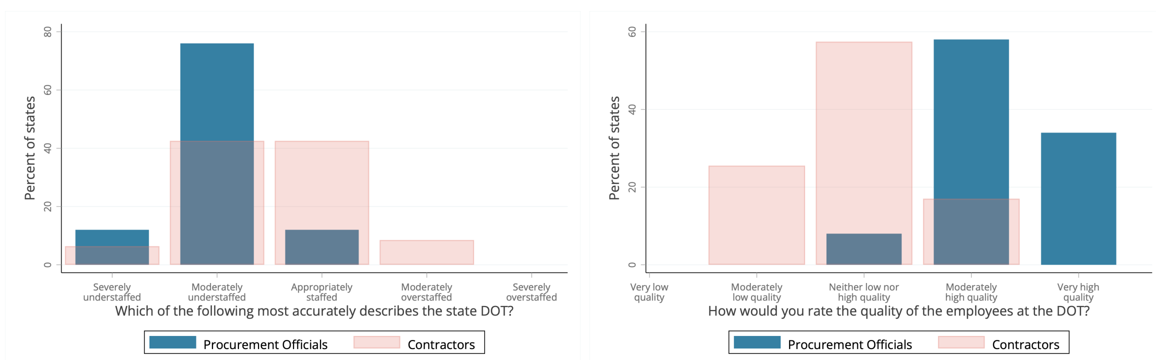
4 Survey Descriptives

In this section we review some findings from the survey on the procurement process: where states are in agreement, where there is substantial variation, and what respondents think drive costs.

4.1 Consensus across respondents

Figure 2 shows that procurement officials agree on a few key issues. First, they are understaffed. Almost 90% of respondents answered that their state DOT was severely (20%) or moderately (68%) understaffed. Figure 2(a) shows this summarized at the state level. Second, employee quality is relatively high. About 30% of the respondents rated the quality of the employees at the DOT as "very high", 51% at "moderately high," and 20% at "neither low nor high" (Figure 2(b)). Lastly, procurement officials agree that corruption is not a problem—almost 80% responded "very small" to "How large of a problem would you rate corruption?" (Figure B.2(a)). We note that the contractors do not always agree with procurement officials —contractors are less likely to say the state DOT is understaffed or high quality, and slightly less likely to say that corruption is a very small problem.

Figure 2: Consensus among Procurement Officials



(a) Staffing Levels

(b) Employee Quality

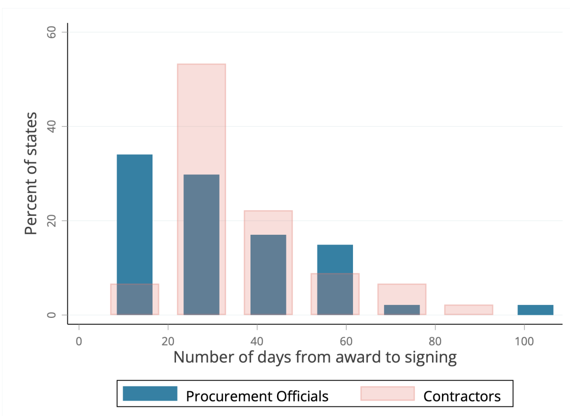
Notes: Author survey: survey question on x-axis and frequency of response on y-axis. Data aggregated to the state level. Survey available in Appendix E.

4.2 Variation between states

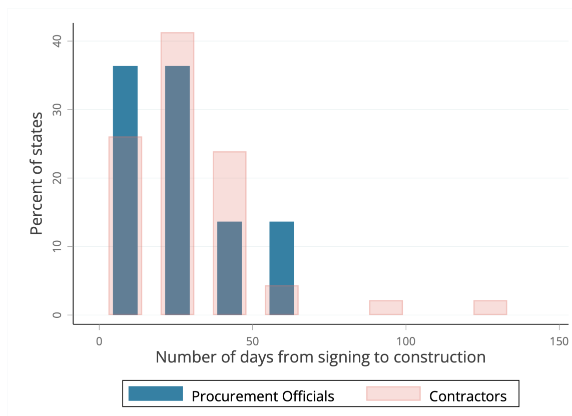
We find significant variation across states in a few key topics. The first is the length of the stages of the procurement process, highlighted in Figure 3(a) and (b). For example, states report taking anywhere between 5 days and 3 months between awarding the contract and having the contractor actually sign the contract. The average time between award and signing is roughly one month, but the standard deviation is 22 days. Then, after signing, it can take another 2 months to start construction. Here the average is just under a month, and a standard deviation is 18 days. At each step of the process, increasing the amount of time between the bid letting and the actual construction will increase uncertainty in costs and contractor capacity. The contractors report an even higher number of days in each category.

Recall a few of the hypotheses from Section 2.2: Announcing the Project and Collecting Bids. We hypothesize that publishing more information on plans should decrease costs, but more information on bidders should increase costs, and outreach efforts should decrease costs. There is variation across states in all three, and also in the method DOTs use to estimate costs that they publish for the bidders (Figure 3(c) and (d)). This preliminary evidence suggests that consensus on "best practices" is far away.

Figure 3: Variation Across States

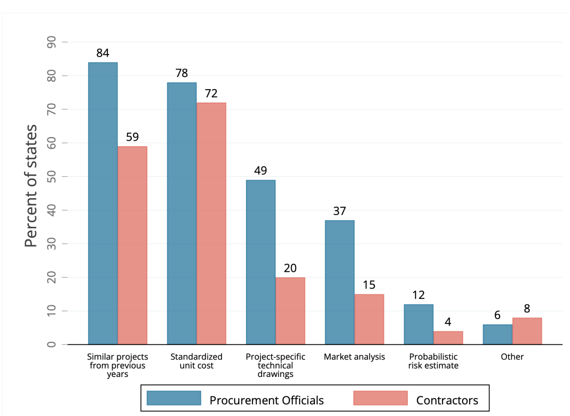


(a) Award to Signing

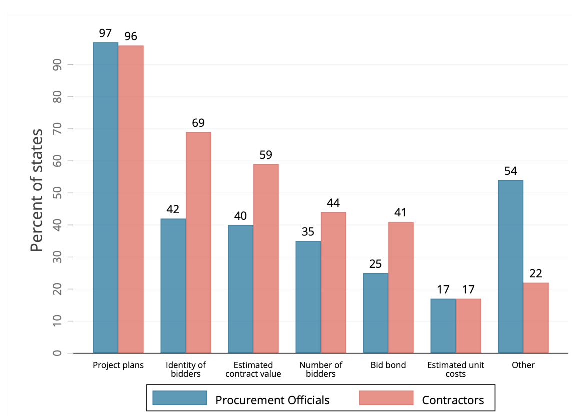


(b) Signing to Construction

I. Project Timing



(c) Creating Estimate



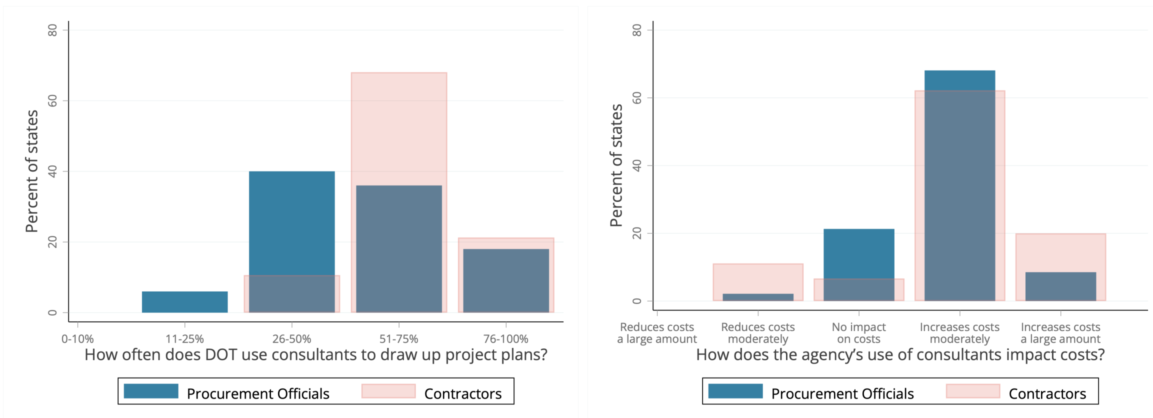
(d) Information Included

II. Announcing the Project

Notes: Author survey. Panels (a) and (b) ask the number of days from contract award to signing and contract signing to the start of construction. Panels (c) and (d) ask respondents about the methods the DOT uses to estimate the contract value and projected schedule (c) and the information the DOT publishes before bids are due (d). Respondents are directed to select all answers that apply. Data aggregated to the state level. Survey available in Appendix E.

Another interesting source of variation comes from the use of consultants. Figure 4 shows that there is considerable variation in how often the DOT uses consultants to draw up project plans, but consensus that using consultants increases costs at least moderately. This is likely tied to the fact that the state DOTs are understaffed. Even though using consultants increases costs, the DOT does not have the capacity to do the work in-house.

Figure 4: Consultants



(a) Variation in Consultant Use

(b) Consultants and Costs

Notes: Author survey: survey question on x-axis and frequency of response on y-axis. Data aggregated to the state level. Survey available in Appendix E.

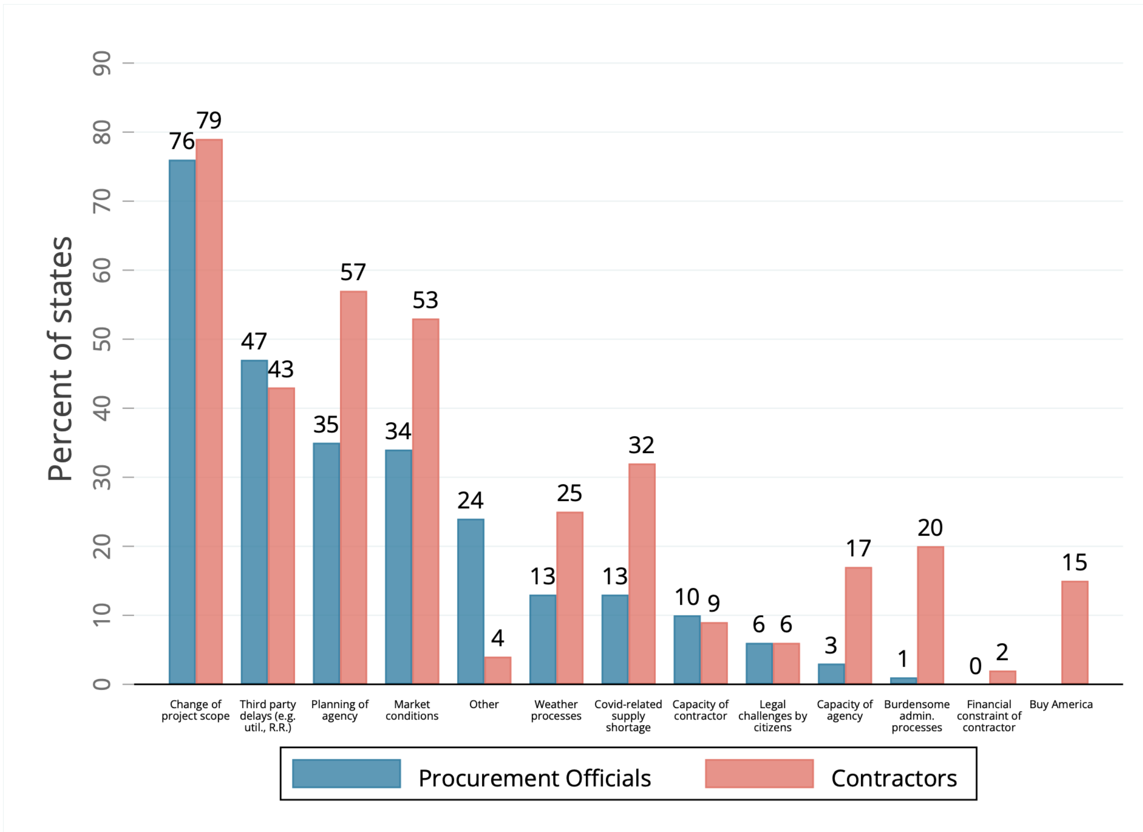
4.3 Cost drivers

Figure 5 summarizes what procurement officials think drive costs. Respondents were free to choose as many items as they wanted. The most common cause of cost overruns cited by procurement officials was "change of project scope." This was also frequently mentioned in the free response. For example, one officer writes, "Bad or unclear specifications or contracts breed uncertainty, which contractors will factor into their prices as risk." Similarly, many officials specifically cite incomplete project plans as a source of costs, writing, "Vague or unclear contract plans and/or language," and, "Ambiguity in the specifications," when asked about what they think increases costs.

These preliminary narrative from the survey suggest that state DOT capacity has shrunk so much that costs are driven up. This leads to both outsourcing to consultants and a reduction in the detail in project plans. The lack of specificity in plans introduces risk to the contractor which increases contractor bids, and opens up the DOT to costly and time consuming renegotiation process when scope of project changes.

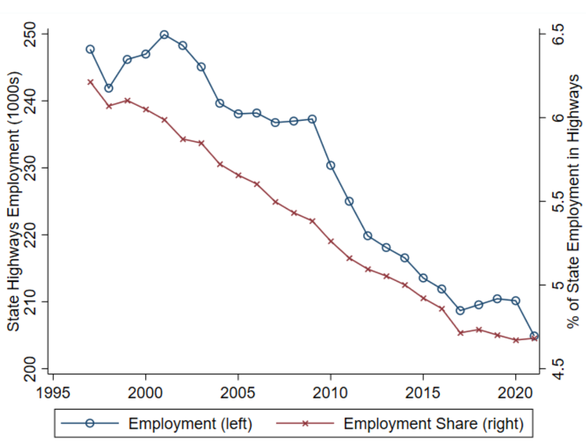
We use administrative data on public sector employment to investigate capacity issues in state DOTs. We see that state DOT employment has experienced a substantial decline in the last 20 years.

Figure 5: Cost Drivers

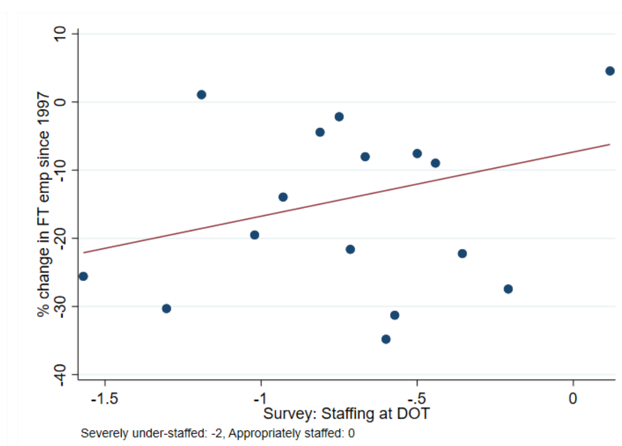


Notes: Author survey. Respondents are asked "If a project has a cost overrun, what are usually the main reasons? Select all that apply." Data aggregated to the state level. Survey available in the Appendix.

Figure 6: State Highway Employment



(a) Time Series



(b) Survey

Notes: The panel on the left shows the total state employment in the "Highway" category, both in levels and as a share of public sector employment (US Census Bureau, 1997-2021). The panel on the right correlates the state specific "highway" employment change with state-level concerns about staffing, as measured by the author survey. The state-level "highway" employment change is measured from 1997 to 2021, but the figure looks similar using a shorter time span for the difference.

Between 1997 and 2020 the number of people employed in state "Highways" (as defined by the Census Annual Survey of Public Sector Employment and Payroll) has shrunk by 40,000, a decrease of about 20%. Total state public sector employment rose over the same period, such that "Highways" share of total state public employment shrunk from over 6% to about 4.5% (Figure 6(a)). The states that experienced the largest losses in employment are most likely to report being understaffed.

The second theme that arises from the survey responses is a problem with competition. Procurement officials often mention competition explicitly when asked to describe cost drivers in their states:

- "A main aspect that increases construction costs in [state] is competition. The timing of project lettings, the number of projects advertised on lettings, and the availability/workloads of contractors all factor into the competition. Increasing the number of bidders reduces procurement costs."
- "Advertising period (Inadequate or too short of an advertising period, time of year chosen to advertise, other projects in the area that will be ongoing simultaneously)"
- "Competition: Costs tend to rise when the number of bidders falls (e.g., a single bidder can 'try' to name their price). Number of bidders tends to fall as the market reaches capacity."
- "Contractor availability" (mentioned multiple times)
- "Limited funds cause limited projects cause limited contractors cause limited competition. Years of limited work has caused many contractors to get out of the business. Now we have very few contractors. Limited competition causes higher prices."

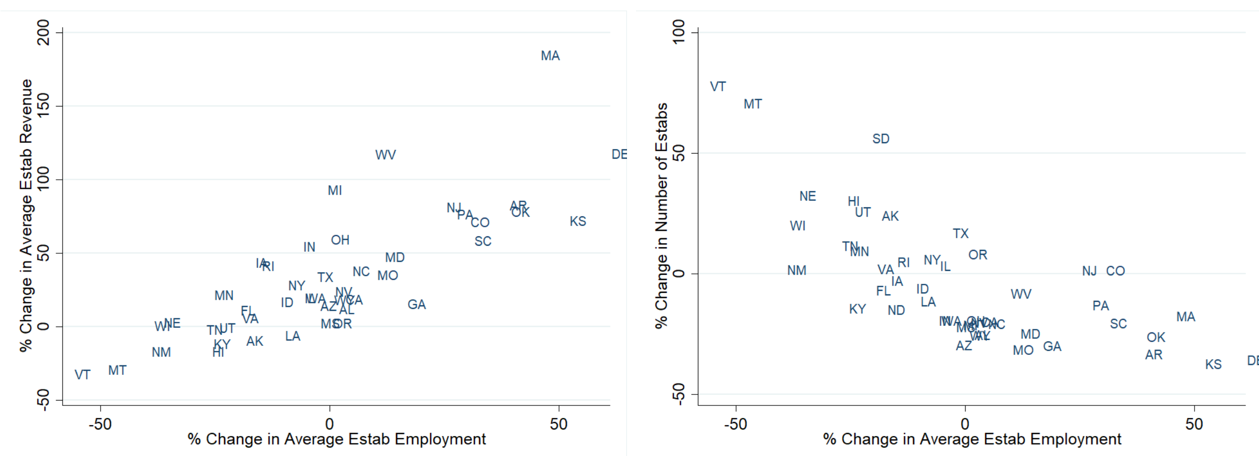
Despite the focus on competition and contractor availability in the free response, 70% of states *rarely* do bidder outreach (Appendix Figure B.2(b)). This could be because the DOT has low capacity or willingness to do outreach, or because they know the market well and no other capable firms exist in the area.

The survey responses of the contracts shows how a lack of competition can have immediate implications for costs. Appendix Figure B.4(a) shows that in states where competition is mentioned as a concern, contractors report expecting to face fewer competitors. Moreover, the fewer competitors a contractor expects to face, the higher the probability they know all of their competitors, and thus likely have some information about competitor's capacity and costs (Appendix Figure B.4(b)).

Contractors also mention competition as a cost driver, but they focus on competition for subcontracting, which they observe downstream of themselves. Contractors and procurement officials agree that the Disadvantaged Business Enterprise (DBE) Program, which is a federal program and not one where we would see much state variation, is a large cost driver (Figure B.3). Contractors are more likely to also cite the Minority and Women Owned Business Programs, which have more variation in state implementation. This links to competition via the subcontracting process—the DBE/MWBE requirements lead to fewer available subcontractors, and increases costs, according to contractor answers in the free response.

We use administrative data on industry structure to study the competitive landscape. We observe a change in the market structure in the highway construction industry over the last 10 years, with most states losing establishments. Almost 70% of states experienced a decrease in establishments in the Highway Construction industry over the period of 2007-2017 (Figure 7(b)), with the median state experiencing a decrease of 13% in total industry establishments.[12] The states that lose establishments also have establishments that are larger and take in more revenue (Figure 7(a)).

Figure 7: Trends in the Highway Construction Industry



(a) Establishment Size and Revenue

(b) Establishment Size and Count

Notes: The panel on the left shows the change in employment and revenue for the average highway construction establishment in each state. The panel on the right shows the change in the number of and the size of the average highway construction establishment in each state. Data on establishment counts, employment, and revenue are from US Census Bureau (2007,2012,2017), and we subset to the "Highway, Bridge, and Street Construction" industry (NAICS 2373). Generally, it seems that most states are experience losses in total number of establishments and growth in establishment size. Changes are calculated over a 10 year period, due to data availability (2007 to 2017).

The survey respondents are concerned with two inputs to the procurement process: DOT capacity and competition between contractors. We see these two themes highlighted in many different survey responses, and we use external data to verify that both capacity and competition have worsened in the recent past. In the next section we will link these two concerns, and other procurement practices

[12] A 13% decrease translates to a loss of 17 establishments.

that we record with the survey, to realized infrastructure costs.

5 Correlations

This section shows the correlation between our measures of costs and potential cost drivers. We first correlate our project-level cost data with project characteristics, and cost drivers at the state and local level (i.e. wages and climate). We will use this set of observables as controls when we correlate costs with procurement practices. Here, we also use non-survey observables that are motivated by the survey responses: an external measure of DOT capacity and the number of bidders collected from the project plans. Both these variables correlate with costs. Then we move to the correlation between costs and the survey responses.

5.1 Observables and Costs

Table 1 shows the relationship between project-level resurfacing costs and established cost drivers, which include project level details, local characteristics, and weather.[13,14] The standard errors are clustered at the state level, and we have 5 projects per state. The project level details include a dummy for whether the project involves non-standard work in addition to the resurfacing (we call this "Complex"), the size of the project ("Lane-Miles"), and a dummy for whether the project is on a state highway, as opposed to an interstate ("State-Highway"). Column (1) shows that as expected, the complex projects are more expensive. There are also fixed costs of resurfacing: longer projects cost less per lane-mile, which is consistent with discussions we have had with highway engineers.

In Column (2) we add local characteristics that can affect resurfacing costs. This includes labor inputs, as measured by wages in the "Highway, Bridge, and Street Construction" industry (NAICS 2373). This industry classification includes new work, reconstruction, rehabilitation and repairs, so it is not exclusively resurfacing industry wages, but would encompass the wages paid for the projects in our database. We can measure wages at the MSA or county level, and as expected wages are positively correlated with costs. Our other local variable is population density in the county of the project. Population density is also positively correlated with costs. This could be due to both road use, which affects the amount of work needed to be done for the resurfacing job, and due to traffic stoppage and diversion during the project completion.

In Column (3) we add variables to capture the climate of the state. It is well established that states with more snow and longer winters have higher costs, due to the shorter window that contractors

[13] External data sources are described in Appendix D.

[14] We talked on background to helpful DOT engineers to verify the established cost drivers.

have to complete the jobs and due to the toll the salt takes on the roads. The state level weather characteristics have the expected signs, where costs are higher in states with more snow and lower in warmer states.[15]

Table 1: Costs and Observables

	Project Cost per Mile (log($M))					
	(1)	(2)	(3)	(4)	(5)	(6)
Project Details:						
Complex Dummy	1.027***	0.948***	0.932***	0.880***	0.848***	-0.082
	(0.270)	(0.259)	(0.281)	(0.266)	(0.226)	(0.095)
Lane-Miles	-0.023***	-0.023***	-0.024***	-0.024***	-0.022***	-0.005
	(0.006)	(0.006)	(0.004)	(0.004)	(0.003)	(0.007)
State Highway Dummy	-0.234*	-0.273*	-0.067	-0.083	-0.113	0.104
	(0.133)	(0.140)	(0.127)	(0.129)	(0.123)	(0.144)
Engineer's Estimate (log(Cost/Mile))						0.838***
						(0.158)
Local Characteristics:						
Log (Population Density)		0.026	0.067+	0.056	0.062+	0.026
		(0.044)	(0.040)	(0.041)	(0.040)	(0.030)
Log(Wages in Highway Construction)		0.218	0.344*	0.214	0.178	-0.423+
		(0.171)	(0.196)	(0.207)	(0.210)	(0.253)
State Weather:						
Precipitation Days (Average)			-0.033***	-0.032***	-0.033***	-0.009
			(0.007)	(0.008)	(0.007)	(0.006)
Winter Low (Average)			0.055***	0.052***	0.052***	0.009
			(0.011)	(0.012)	(0.011)	(0.011)
Snow Proxy			0.021+	0.033**	0.037**	0.008
			(0.014)	(0.016)	(0.015)	(0.009)
Summer High (Average)			-0.057***	-0.066***	-0.065***	-0.011
			(0.021)	(0.021)	(0.020)	(0.023)
Potential Cost Drivers:						
DOT Employment/Population (1,000)				-0.263+	-0.261+	0.022
				(0.165)	(0.158)	(0.113)
Number of Bidders				-0.011	-0.020	-0.083**
				(0.044)	(0.036)	(0.035)
Observations	250	250	250	250	247	94
R-squared	0.18	0.19	0.35	0.37	0.38	0.68

Notes: This table presents a simple regression between resurfacing costs and potential cost drivers. The project-level costs and project level characteristics (including number of bidders) are collected from the author, and the data on other observables is described in detail in Appendix D. Standard errors are clustered at the state level. "Lane-Miles" is the size of the project (lanes × length of highway), "Complex" is a dummy to denote that the project involves work beyond a standard resurfacing job, and "State Highway" is a dummy to denote it is a state highway resurfacing project, as opposed to an interstate. Column (5) restricts the sample to projects with a cost per lane mile less than $2.5 million, dropping 3 outlier projects. Column (6) adds the "Engineer's Estimate" i.e. the projected cost per mile (only available for 19 states). This estimate controls for all of the observables (i.e. project details, weather, local characteristics), rendering those correlations insignificant and allowing us to focus on the role of the number of bidders.

Finally, in Column (4) we introduce two variables that capture some of the most cited cost drivers from the survey: DOT capacity and competition. For DOT capacity we take the number of full-time

[15] We do not have a direct measure of snowfall but proxy this with the average precipitation in the state multiplied by the inverse of the winter high temperature.

employees in state highways (from the Annual Survey of Public Sector Employment and Payroll) and divide it by the state population. For competition we use the number of bidders, which is a project-level variable that we collected directly from the state. As hypothesized, states with higher capacity have lower project costs. The relationship between competition and costs is much weaker.[16] We further investigate this by controlling for the "Engineer's Estimate" in Column (6). This is the DOT's best estimate of how much the project will cost, which is why all of the other observables we use to explain costs are no longer statistically significant—these are taken into account in the estimate. Once we control for the "Engineer's Estimate", and therefore unobservables that affect bidder participation, we see a strong negative correlation between the number of bidders and costs, as expected.[17] One additional bidder is associated with 8% lower costs per mile.

5.2 Procurement Practices and Costs

After analyzing how project-level costs vary with state and project observable characteristics, we look to see how much of the remaining variation is explained by the differences in procurement practices across states that our survey uncovers.

We take the survey responses and correlate them with the project-level cost data. The dependent variable is log cost per mile, as in Table 1. We also control for all of the project, local, and weather observables that we included in Column (3) of Table 1, and cluster standard errors at the state level. The survey responses from the procurement officials and the contractors are aggregated to a state-level average, unless the question was only asked to one group.

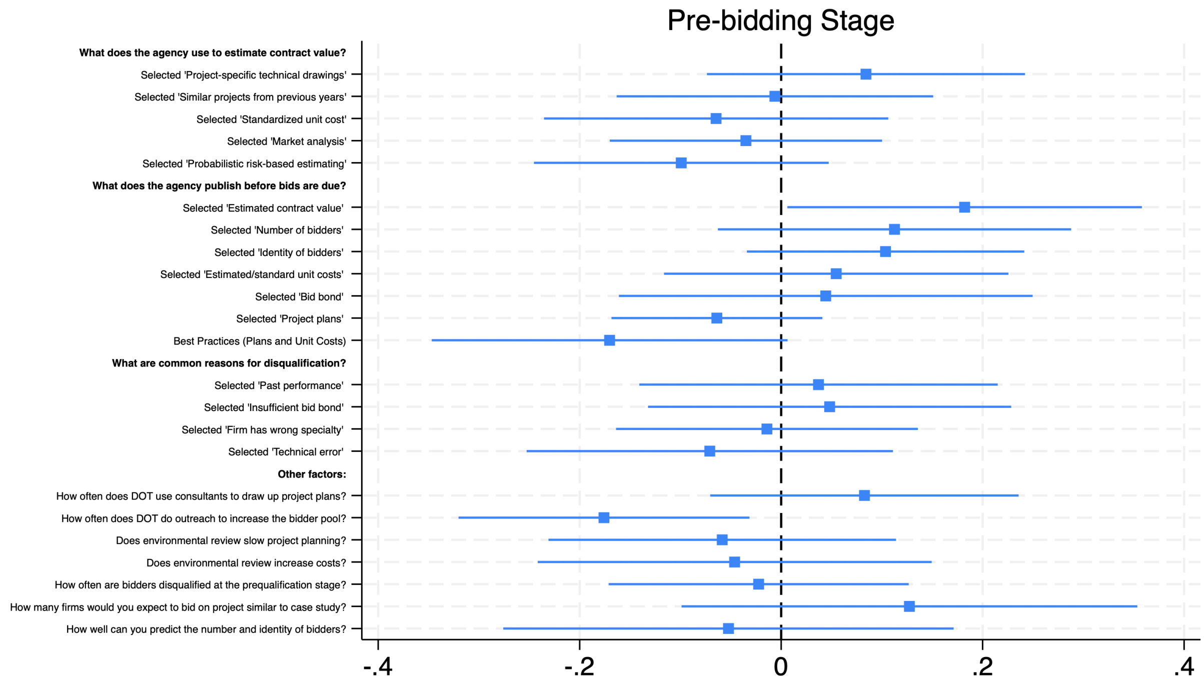
Given the number of survey questions, we display the correlations in a set of coefficient plots. Each response variable is normalized to have a mean of zero and standard deviation of one, such that correlations are comparable across questions. We separate the responses by the stage of the procurement process, following our discussion in Section 2. The coefficient plots display the coefficient and the 95% confidence interval.

Both procurement practices and costs vary widely across states. But most state-level procurement practices do not correlate with realized costs. However, the correlations that emerge are consistent with the two themes that predominated in the descriptive statistics: 1) limited state DOT capacity and 2) limited competition.

[16] Column (5) repeats the analysis but restricts the sample to projects that cost under $2.5 million per lane mile. This only reduces the sample by 3 observations, and the correlations with the observables do not change. Therefore, we use this set of project details, local characteristics, and state weather variables as controls when we correlate costs with the survey outcomes.

[17] Unfortunately we only have data on the engineer's estimate for 19 states, which is why we do not use it more broadly across our analysis.

Figure 8: Survey Correlates: Pre-Bidding



Notes: This figure shows the correlation coefficients between the survey responses and the project cost for the pre-bidding stage of the procurement process. The dependent variable is log cost per lane-mile. Regressions include controls for project, local, and weather observables (per Column (3) of Table 1), and cluster standard errors at the state level. The survey responses from the procurement officials and the contractors are aggregated to a state-level average, unless the question was only asked to one group. The bars represent the 95% confidence interval. Each response variable is normalized to have a mean of zero and standard deviation of one, such that correlations are comparable across questions.

Figure 8 shows the correlations between procurement practices in the pre-bidding stage and realized costs. A few correlations stand out, namely, in estimating the contract value the states that use project-specific technical drawings have slightly higher costs, and those that use probabilistic risk-based estimating have lower costs. In terms of the information published to potential bidders, states that publish estimated contract value have relatively higher project costs, while states that publish project plans have lower costs.[18] Providing information on the number and identity of bidders is also associated with higher costs.

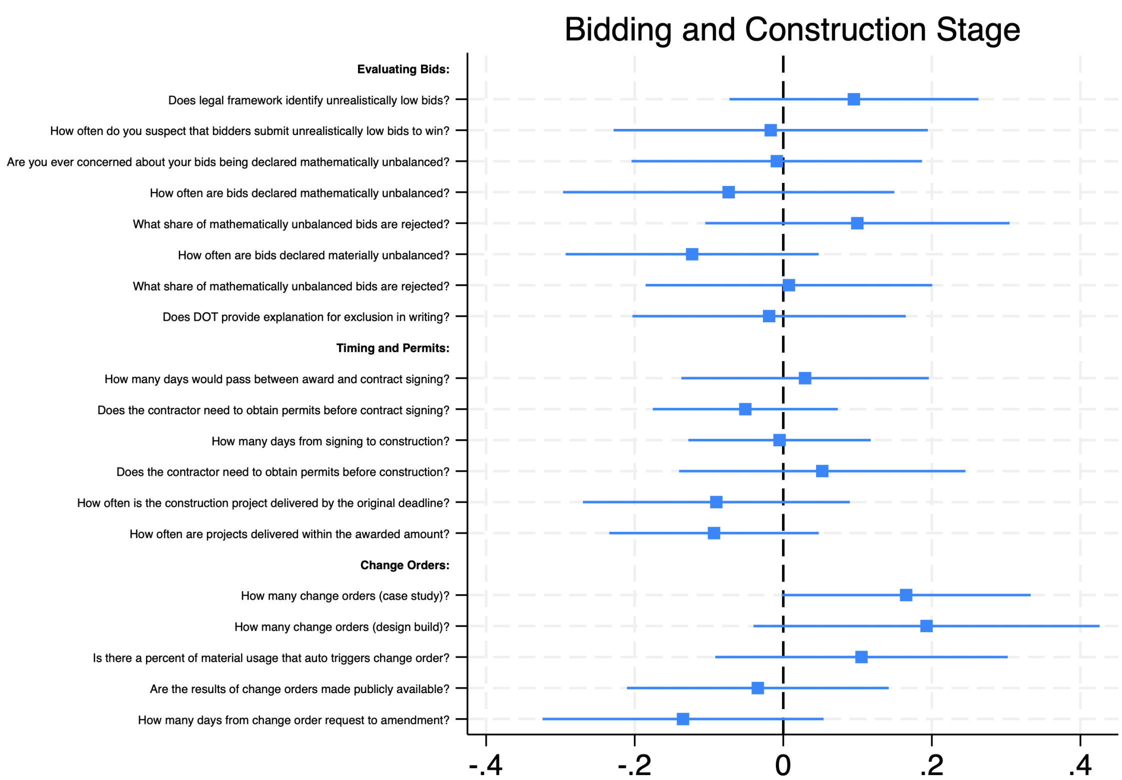
The positive correlation between publishing estimated contract value and costs is somewhat surprising, though it is possible that the state systematically overestimates costs and anchors bidders to an inflated price. Another possibility is that estimated contract value provides some information to the bidders, but is not as informative as estimated unit costs. We create a measure of "Best Practices" which sums the selection of 'Project Plans' and 'Estimated standard unit costs', and subtracts

[18]We should note that the majority of states publish project plans, so the lack of project plans is particularly bad practice.

the other selections ('Estimated contract value', 'Number of bidders', 'Identity of bidders' and 'Bid Bond'). Therefore, to have the highest score on "Best Practices" the state would publish project plans and estimated standard unit costs, but nothing else. This is negatively correlated with costs.

The most striking correlation in this figure is the bidder outreach variable. States that do outreach to increase the bidder pool have significantly lower costs, highlighting both the importance of competition and the role the DOT can play in order to increase it.[19] A one standard deviation (12 percentage point) increase in bidder outreach is correlated with a 17.6% decrease in costs. At the mean, this translates to a decrease in costs of $65,000 per lane-mile and $1 million at the project level.

Figure 9: Survey Correlates: Bidding and Construction



Notes: This figure shows the correlation coefficients between the survey responses and the project cost for the bidding and construction stages of the procurement process. The dependent variable is log cost per lane-mile. Regressions include controls for project, local, and weather observables (per Column (3) of Table 1), and cluster standard errors at the state level. The survey responses from the procurement officials and the contractors are aggregated to a state-level average, unless the question was only asked to one group. The bars represent the 95% confidence interval. Each response variable is normalized to have a mean of zero and standard deviation of one, such that correlations are comparable across questions.

Figure 9 shows the correlations between procurement practices in the bidding and construction

[19] This has also been found to be important to procurement in the Government Performance Lab's work in St. Paul, Minnesota (Government Performance Lab, 2016; Liebman and Azemati, 2016).

stage and realized costs. Here, the procurement process in evaluating bids, and the timing between bid evaluation, signing, and construction do not correlate with realized costs. However, change orders have a positive correlation with costs—the more change orders that are expected the higher the costs. Frequent change orders could directly lead to higher costs through delays and costly renegotiation; they could also be a downstream symptom of poor administrative capacity at a state DOT—many contractors reference poor-quality project plans made by third-party consultants.

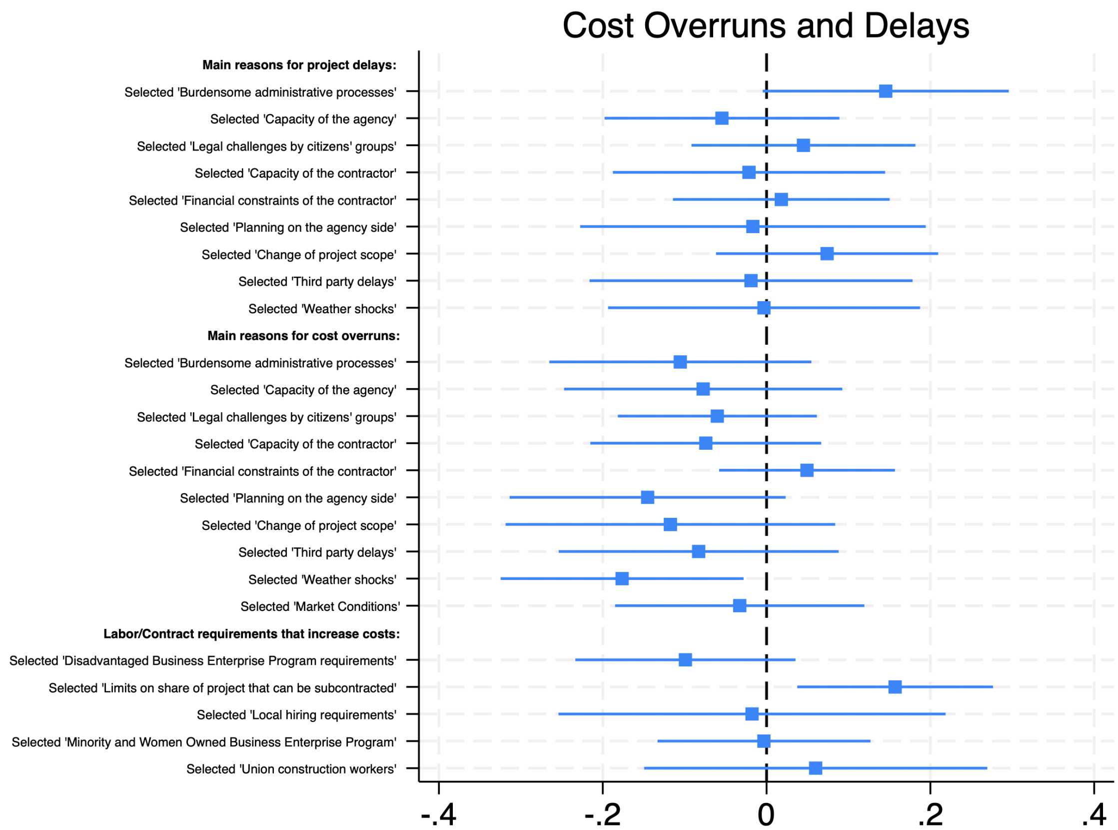
Figure 10 shows the correlations for the survey responses about project delays, cost overruns, and labor and subcontracting requirements. Here, states that are more likely to flag "burdensome administrative processes" as a source of project delays have higher realized costs. Generally, the selections on main reasons for delays or overruns do not have strong correlations with costs, perhaps due to the subjective nature of the question. We do see that selecting "Weather Shocks" as a source of cost overruns is *negatively* correlated with costs. The specific question is "If a project has a cost overrun, what are usually the main reasons?", so it may be that in states where the main reason for cost overrun is weather, things are operating well. We do not see any correlation between changes in project scope and cost, but we do not that the majority of states selected this, so there is not much variation in responses.

The strongest correlation in this section is the relationship between the limits on the share of the project that can be subcontracted and realized costs. A one standard deviation increase in citing issues with subcontracting limits is associated with a 15.7% increase in costs. This is a large effect; in a state where every respondent selects "Limits on share of project that can be subcontracted" as a cost driver realized costs are 62% higher than in a state where none of the respondents select subcontracting limits, all else equal. All projects that receive federal funding have an upper bound for subcontracting of 70% of contract value.[20] Many state DOTs adopt this regulation for all projects, though some pick a higher own-work threshold; in Vermont the upper bound is 50%. A high own-work threshold could increase costs for asphalt or concrete resurfacing contracts by increasing fixed costs and decreasing competition: if paving materials form a high enough share of the contract value, then only firms with in-house manufacturing ability will be able to bid.

Lastly, Figure 11 covers the non-procurement specific questions: DOT characteristics, Contractor characteristics, and corruption. First, consistent with an earlier discussion of consultants, states where respondents cite consultants as a cost driver have significantly higher costs. Also, states where

[20] Generally, subcontracting limits may be either lower or upper bounds—in the case of DBE regulations, there is sometimes a lower bound on how much of a contract's value must be let out to a DBE-qualified subcontractor. The relationship between subcontracting limits and costs does not seem to come from DBE-related lower bounds: states that cite DBE requirements as a cost driver do not seem to have higher realized costs. Though, in the project-level DBE goal data we do see a positive correlation.

Figure 10: Survey Correlates: Overruns and Delays

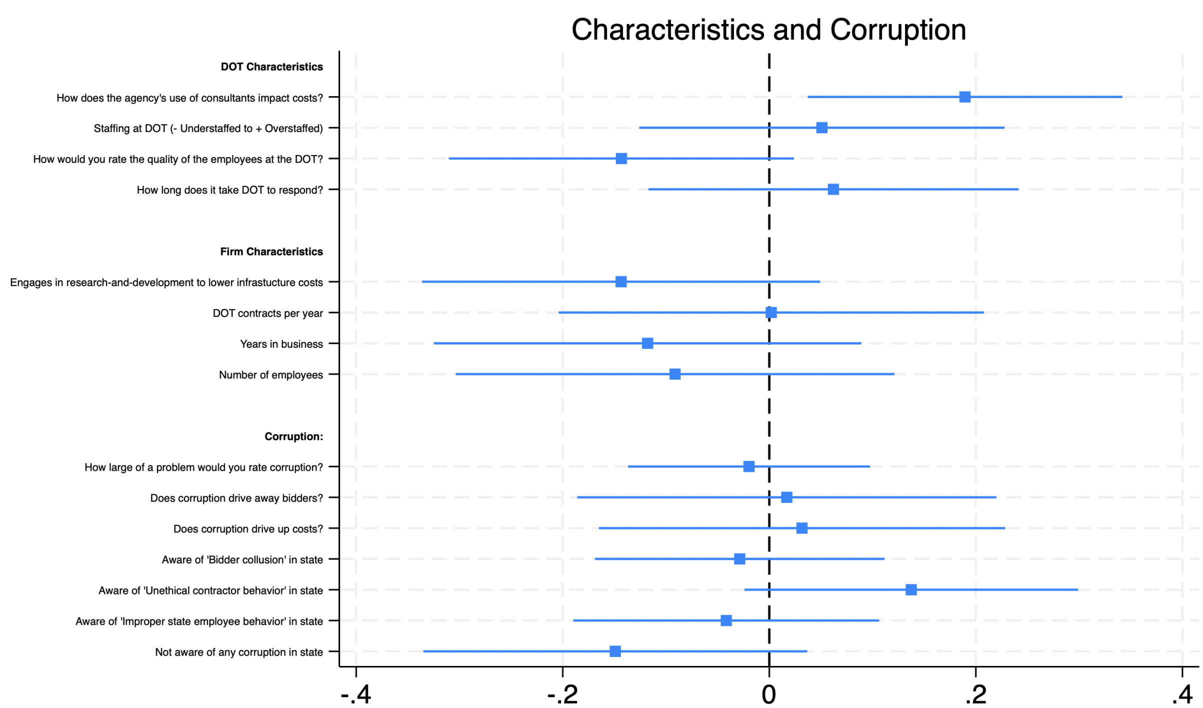


Notes: This figure shows the correlation coefficients between the survey responses and the project cost for the questions about cost overruns, delays, and labor costs. The dependent variable is log cost per lane-mile. Regressions include controls for project, local, and weather observables (per Column (3) of Table 1), and cluster standard errors at the state level. The survey responses from the procurement officials and the contractors are aggregated to a state-level average, unless the question was only asked to one group. The bars represent the 95% confidence interval. Each response variable is normalized to have a mean of zero and standard deviation of one, such that correlations are comparable across questions.

DOT employees are rated more highly have lower costs, again speaking to DOT capacity. A standard deviation increase in DOT quality is correlated with a 14.3% decrease in costs. A state with a neutral rating has 28.6% higher costs than one that rates the DOT employees as "moderately high quality", all else equal.

Here, most corruption variables do not correlate with costs, and we already know that corruption was not a concern in the majority of states (Appendix Figure B.2(a)). However, in the few states that mention unethical contractor behavior, costs are significantly higher. A state where half of respondents cite unethical contractor behavior has 44% higher costs than a state where no respondents make the selection. Similarly, in states that have no concerns about corruption, costs are lower. One standard deviation in selecting "Not aware of any corruption" is associated with 15% lower costs.

Figure 11: Survey Correlates: Other Factors



Notes: This figure shows the correlation coefficients between the survey responses and the project cost for the questions about DOT and Contractor characteristics and corruption. The dependent variable is log cost per lane-mile. Regressions include controls for project, local, and weather observables (per Column (3) of Table 1), and cluster standard errors at the state level. The survey responses from the procurement officials and the contractors are aggregated to a state-level average, unless the question was only asked to one group. The bars represent the 95% confidence interval. Each response variable is normalized to have a mean of zero and standard deviation of one, such that correlations are comparable across questions.

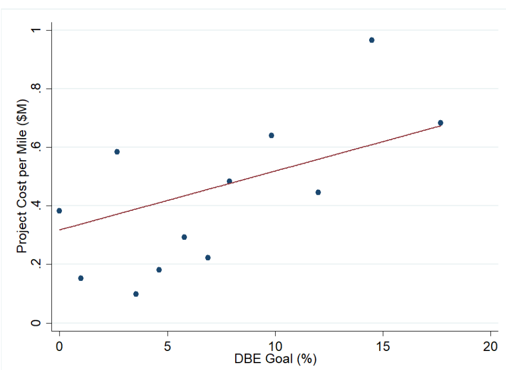
5.2.1 Subcontracting and Delays

In this section we further investigate potential cost drivers that do not emerge in the survey correlations.

Procurement officials and contractors in over 80% of states mentioned the Disadvantaged Business Enterprise (DBE) program as a cost driver (Appendix Figure B.3). However, we do not find any correlation between this response and realized costs. This may be due to lack of variation. To further probe the role of competition in the subcontracting market we collect two variables to measure the market for Disadvantaged Business Enterprise (DBE) firms.

First, at the project level, we assemble the project-specific "DBE goal." This is the percentage of work that the DOT would like to be subcontracted to a DBE. Then, we also create a measure of the thickness of the DBE market by calculating the number of registered DBE firms over the number of construction establishments in the state. Figure 12 shows that projects with higher DBE goals cost more–a 10 percentage point increase in the DBE goal is associated with 25% higher costs per mile. However, in states with a thicker DBE market costs are lower.

Figure 12: Costs and the Disadvantaged Business Enterprise (DBE) Program



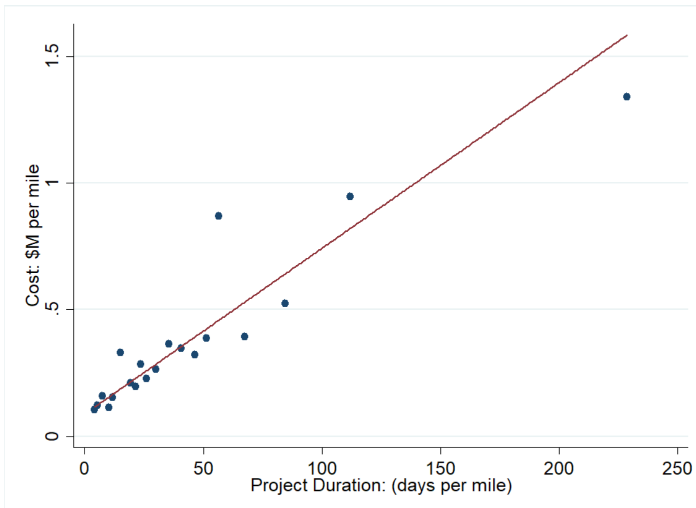
	Project Cost per Mile (log($M))		
	(1)	(2)	(3)
Project DBE Goal (%)	0.022+		0.025+
	(0.015)		(0.015)
State DBE Share		-0.026	-0.220
		(0.315)	(0.297)
Observations	119	119	119
R-squared	0.49	0.48	0.49

Notes: The figure on the left shows a binned scatter plot of project-level costs and DBE goals. The DBE Goal % is a project-level variable that denotes the amount of the project that should be completed by a DBE. This is collected by the authors from bid lettings and is available for projects in 32 states. This table on the right presents a simple regression between resurfacing costs and the Disadvantaged Business Enterprise program. The regressions include all of the controls from Column (4) of Table 1 (project details, local characteristics, state weather, and potential cost drivers). Standard errors are clustered at the state level. The DBE Share is a state-level variable that measures the number of construction firms registered as a DBE, as a share of the total number of construction firms. This is collected by the authors by downloading DBE registries in each state that it is available (36 states).

Next, the average length of time between procurement steps at the state level and other questions about delays do not correlate with realized costs, which goes against common wisdom on the cost of delays. However, we note that costs and project duration exhibit a tight positive relationship. We have project duration for projects in 33 states. Figure 13 shows the relationship between cost per mile and days per mile: a standard deviation increase in duration (50 days per mile) correlates with

43% higher costs per mile. This is consistent with the discussion of the role of delays in Section 2.4. For this reason, we also correlate the project duration variable with the survey responses in Appendix B.1. Here, we find many similarities to the cost correlations, and a few additional variables, such as the timing questions, that correlate highly with delays.

Figure 13: Costs and Project Duration



Notes: This is a binned scatter plot of project-level costs and duration. The y-axis shows the cost per lane-mile, in $M. The x-axis shows the duration per lane-mile, in days. The data was collected by the authors, as part of the project-level cost data. The project duration variable is only available for 33 states.

6 Conclusion

US infrastructure construction costs are high by international standards and increasing. At the same time, costs vary greatly across states within the US. This paper is the first to use cross-state evidence to understand what role procurement practices play. To study this, we assemble and combine three novel datasets: (1) we conduct a survey of state procurement officials and contractors about state procurement practices and cost drivers, (2) we collect state-by-state a project-level data set of construction costs, and (3) we assemble administrative data on the construction industry that completes projects and the public sector industry that manages projects.

We find especially strong evidence for two main cost drivers.

First, weak state capacity increases costs. Respondents overwhelmingly think that state DOTs are understaffed. And low staffing and low quality correlate with higher costs. Weaker state capacity could increase the use of consultants and the number of times projects must change after being bid, which also correlate with higher costs.

Second, limited competition reduces costs. Having fewer bidders correlates with higher costs. And so do specific practices that limit competition: restricting the number of subcontractors and limiting outreach to increase the number of bidders.

Next, we plan to use rich project-level data from a few large states to further investigate state capacity in DOT procurement. Namely, we will exploit variation in DOT engineer experience and consultant use across projects and districts within states.

More broadly, going forward, we hope that others are able to make use of the unique datasets that we have assembled on procurement practices and construction costs. And the striking correlations that we have documented provide guidance on where to dive in more deeply with causal inference designs.

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Appendix

A Cost Data

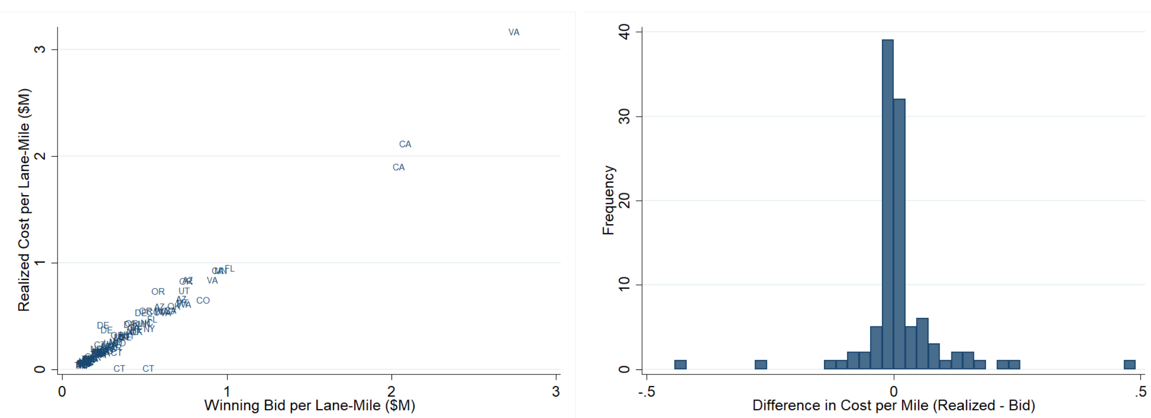
In this Appendix we review some additional descriptives on cost and compare our data with state level aggregates provided by the Federal Highway Administration (FHWA).

A.1 Descriptives

We request data on project-level costs directly from each state DOT. The states provide data in a variety of formats, and include different subsets of the variables that we request. For example, in some states we receive data on three cost variables: winning bid, realized cost, and amended contract cost. However, in some states we only receive one or two of the three. In the states that we only observe winning bid, for example, we want to be convinced that it is a good enough proxy for realized costs for the projects in our subsample.

Figure A.1 compares winning bids with realized costs, in the states where we have both (22 states). The panel on the left plots the two objects in the project level data, and the panel on the right shows the differences, in a histogram. The two objects are highly correlated, with a correlation coefficient of 0.98.

Figure A.1: Bids vs Realized Costs



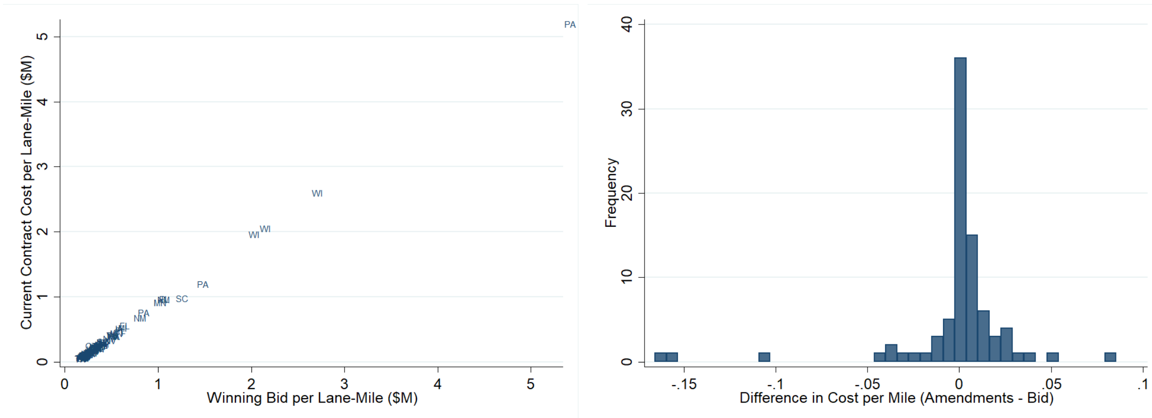
(a) Comparison of Cost per Mile (b) Difference

Notes: This figure compares winning bids with realized costs. The panel on the left plots the two objects in the project level data, and the panel on the right shows the differences, in a histogram. The two objects are highly correlated, with a correlation coefficient of 0.9812.

Figure **??** compares winning bids with "current contract" costs, in the states where we have both (17 states). Current contract costs are the winning bids plus or minus any contract amendments.

Current contract costs are essentially realized costs, unless the project has not been completed. The two objects are highly correlated, with a correlation coefficient of 0.99.

Figure A.2: Bids vs Amended Contracts



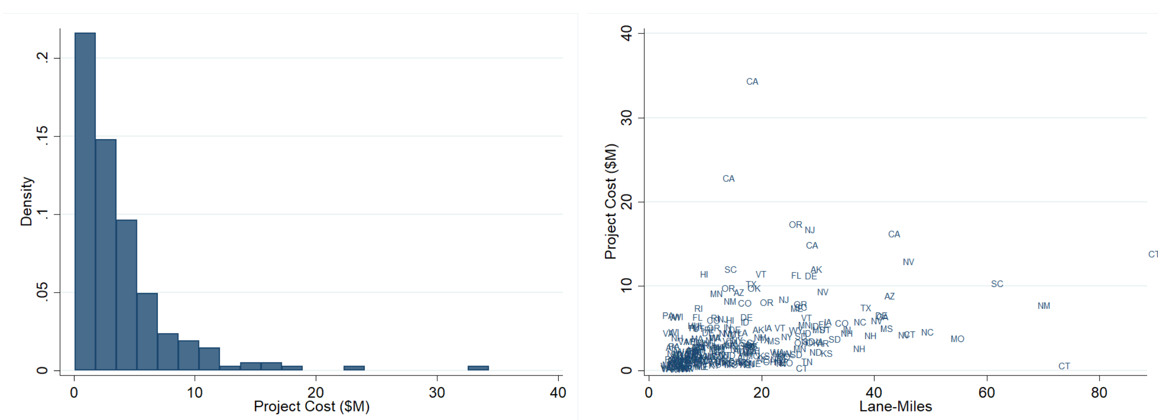
(a) Comparison of Cost per Mile

(b) Difference

Notes: This figure compares winning bids with "current contract" costs. Current contract costs are the winning bids plus or minus any contract amendments. The panel on the left plots the two objects in the project level data, and the panel on the right shows the differences, in a histogram. The two objects are highly correlated, with a correlation coefficient of 0.999.

Our final sample uses the realized cost variable when available (23 states), then the current contract cost if available when realized cost is not (12 states), and the winning bid for the remainder (15 states). Figure A.3 shows the distribution of project costs across the sample and Figure A.4 shows the spending and length of the projects across space.

Figure A.3: Cost Data Sample: Totals

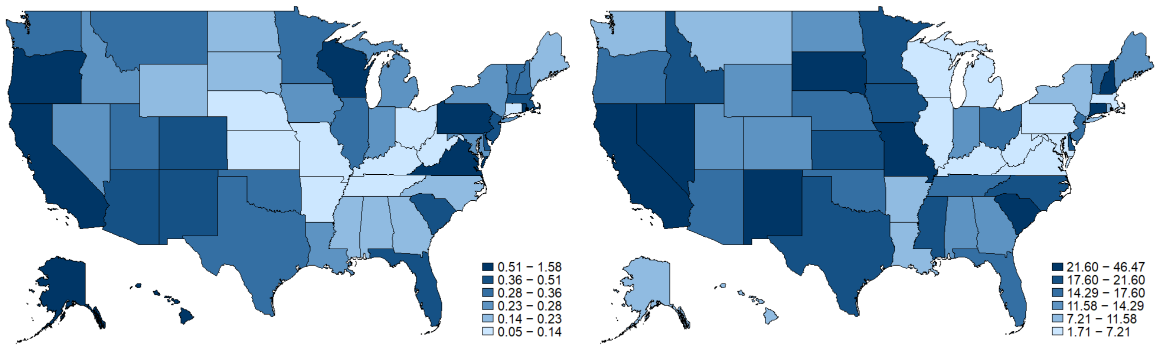


(a) Project-Level Total

(b) Total vs Mileage

Notes: The histogram on the left shows the distribution of project-level costs in the data collected by the authors. The scatter plot on the right takes each project cost and plots it against total mileage of the project (in lane miles). The markers denote the state associated with the project One project that costs $62 million is not included, for visibility..

Figure A.4: Spending and Project Characteristics



(a) State-Level Spending (b) State-Level Mileage

Notes: The map on the left shows project costs per mile, and the right shows the mileage for these projects. The cost data collected by the authors is for resurfacing projects started in 2018 or 2019, with a length between 1 and 20 miles, on a non-interstate highway. There are 5 such projects per state, and the state average is used for this map. Interestingly, project length does seem to vary by state, with some states undertaking much longer projects than others.

A.2 Comparison with the FHWA Data

We can compare our data with state-level cost data from the Federal Highway Administration (FHWA). The FHWA requires states to report spending on a variety of categories and types of roads via an annual survey. As such, these data are self-reported by the states. A potential concern is that states do not all report resurfacing spending, for example, in the same narrow category. A second concern is that we do not have a denominator of miles resurfaced, we only have total miles in the state. Therefore, it is hard to know if cost per mile is higher in one state because they did more projects than another state or because the projects are more expensive. However, this is the only comprehensive dataset on state level costs and is often used in reports about spending across states (e.g. Reason Foundation, 2018).

FHWA data includes spending by category, as we mentioned earlier. Therefore we need to select certain categories to compare with our sample of resurfacing projects. Due to potential reporting issues, we are fairly broad in the categories we include in the series we create. We define our series of interest as "Resurfacing + Maintenance cost per vehicle-mile." This includes all maintenance cost variables and certain capital overlay variables.[21] Vehicle-miles are the estimated number of miles traveled by vehicles on roads in that states. We use all road types in all definitions, but the series looks similar when we exclude local roads. These data are very similar to the series used by Mehrotra, Turner and Uribe (2021). For the FHWA data, we think spending per vehicle-mile is a better measure

[21]The capital outlay variables are "Relocation", "Reconstruction: Added Capacity", "Reconstruction: No Added Capacity", "Major Widening", "Minor Widening", "Restoration & Rehabilitation", and "Resurfacing".

of cost efficiency, as it implicitly controls for the expected degradation due to heavy road use.

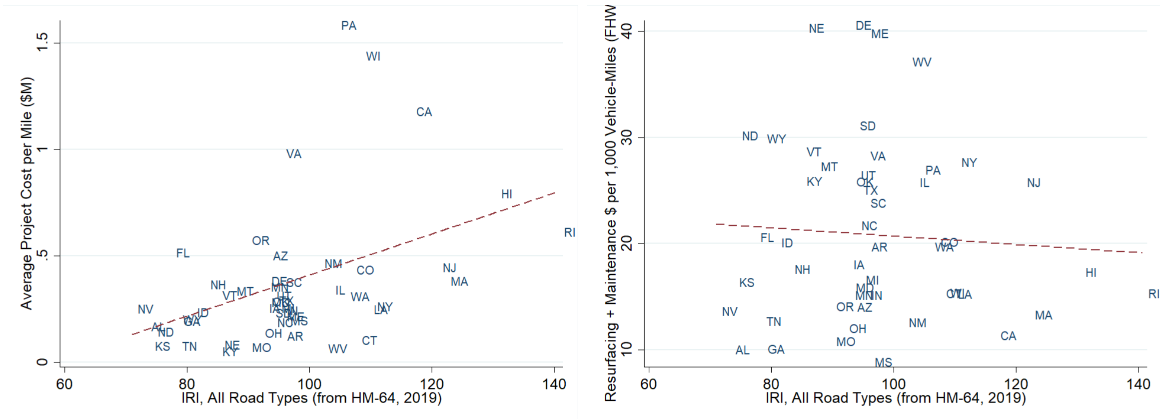
Figure A.5 shows the variation in spending across states for the two sources. There is a striking amount of variation in the FHWA data with Maine, Delaware, and Nebraska spending 4 times per vehicle mile than Mississippi, Georgia, and Alabama. Our series, although still exhibiting variation across states, does not exhibit as much heterogeneity. Importantly, there is very little correlation between the two series. Since we have directly collected resurfacing cost data from the states, this suggests the FHWA data is not a good proxy.

Moreover, it does not seem that costs are higher in areas where roads are rougher in the FHWA data, while our data show a stronger correlation between costs and road quality (Figure A.6). We would expect maintenance costs per lane mile to be higher on rougher, poorer-quality roads, so the lack of correlation with costs in the FHWA data is surprising.

Figure A.5: Comparison of Cost Data

Notes: This is a scatter plot with cost data collected by the authors on the y-axis and cost data collected by the FHWA on the x-axis. The cost data collected by the authors is for resurfacing projects started in 2018 or 2019, with a length between 1 and 20 miles, on a non-interstate highway. There are 5 such projects per state, and the state average is used for this plot. The FHWA cost data is spending on resurfacing and maintenance per vehicle mile.

Figure A.6: Costs and Road Roughness



(a) Cost per Mile and Roughness

(b) FHWA $ per Vehicle-Mile and Roughness

Notes: The panel on the left shows a scatter plot of state level resurfacing cost per mile and road roughness (IRI). The cost data collected by the authors is for resurfacing projects started in 2018 or 2019, with a length between 1 and 20 miles, on a non-interstate highway. There are 5 such projects per state, and the state average is used for this plot. The panel on the right shows the same using cost from Highway Statistics (FHWA). To create the cost series we include a subset of capital outlay costs (relocation, reconstruction, major widening, minor widening, restoration, rehabilitation, resurfacing) plus maintenance costs. We use the International Roughness Index (IRI) as the quality measure.

A.2.1 Comparison of FHWA and BidX Data

To further probe the reliability of the Highway Statistics spending data, we compare it to spending totals that we aggregated from BidX, a private-sector service that many state DOTs contract for its construction bidding software. Data from BidX has also recently been used for research purposes (e.g. Bolotnyy and Vasserman, Forthcoming; Kroft, Luo, Mogstad and Setzler, 2022). BidX posts winning bids for state DOT construction projects for 38 states. They post descriptions for each project, allowing us to select projects of a similar scope to those we look at in FHWA's Highway Statistics.[22]

As a validation exercise, we compare cross-state spending differences in the BidX data with those from Highway Statistics. We first examine Georgia and South Carolina, a pair of states that are similar on observables but have divergent levels of spending per vehicle mile (VM) levels in the Highway Statistics data. In 2018 and 2019, spending per VM is higher in South Carolina in both data sources, but the difference is much larger in Highway Statistics than in BidX.

We repeat the exercise with Georgia and Alabama, two states with very similar spending per VM in Highway Statistics. In the averaged totals across 2014, 2018, and 2019, we find a 15 percent difference between the two states in BidX, whereas the averages in Highway Statistics are virtually identical.

[22]The following keywords are indicative of the projects we are looking for: "resurface", "rehabilitation", "widening", in addition to "mill", "surface", "CMRB". We focused on states that had the most detailed descriptions.

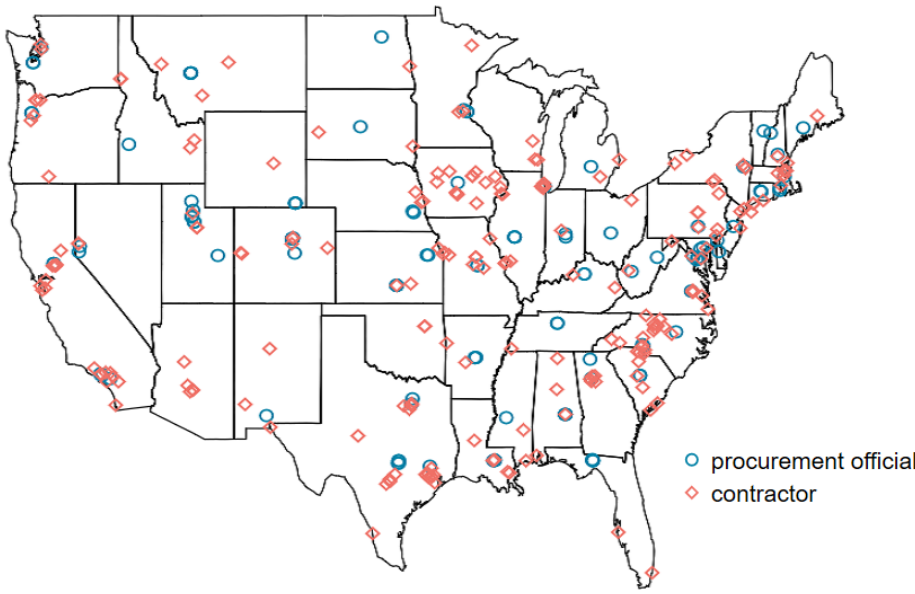
Lastly, we compare New York and North Carolina, which both have high spending per VM in Highway Statistics, to Georgia and Alabama, which both have low spending levels. In 2019, the two datasets disagree: Highway Statistics has the spending per VM significantly higher in NY and NC, whereas BidX has spending per VM significantly higher in Alabama and Georgia. The last comparison also raised a red flag about the internal consistency of the BidX data, as NY has just over 1/3 of the spending per VM as Alabama, which is unlikely to reflect the full universe of spending.

We compare magnitudes of spending in addition to cross-state relative differences. To improve precision, we focus on two categories of spending: resurfacing, rehabilitation, and restoration (3R) and widening/reconstruction. These activities are accounted separately in Highway Statistics and are often grouped together in BidX projects. We choose Georgia for this exercise due to its detailed project descriptions on BidX. In this exercise, the BidX magnitudes are well below those we observe in Highway Statistics.

Overall, it appears that BidX does not typically include the universe of spending laid out in Highway Statistics, and that the degree of the coverage gap in BidX data varies widely by state.

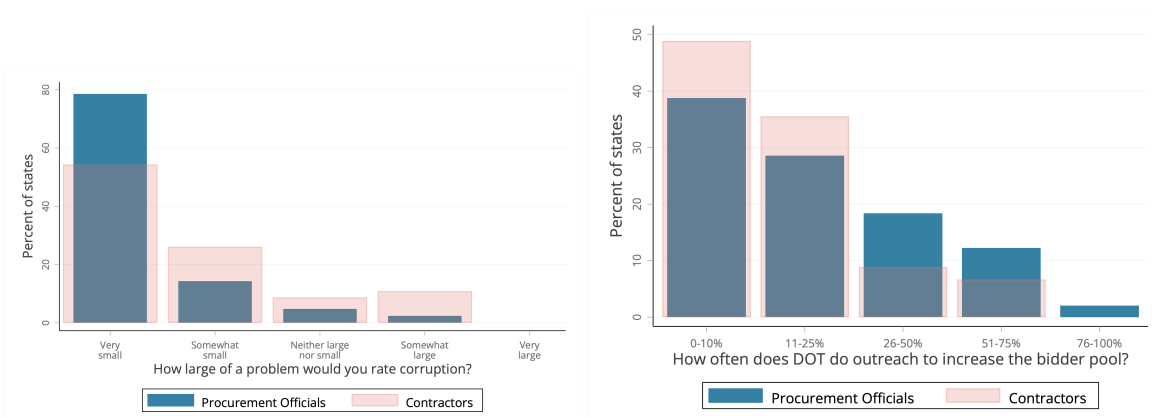
B Additional Survey Descriptives and Correlations

Figure B.1: Survey Respondents



Notes: Survey respondents are geocoded to the location where they completed the survey. Procurement officials are marked with blue circles, and contractors are marked with red diamonds.

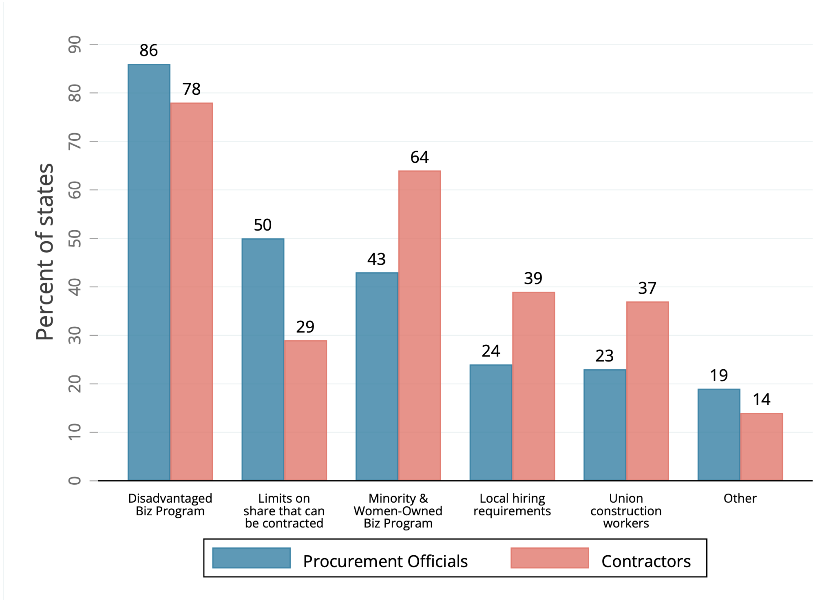
Figure B.2: Survey Consensus



(a) Corruption (b) Bidder Outreach

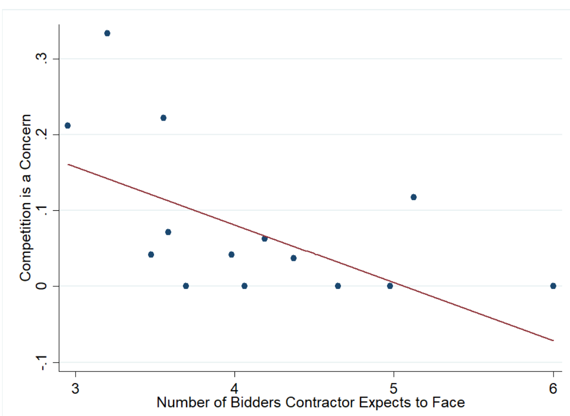
Notes: Author survey. Data aggregated to the state level. Survey available in Appendix E.

Figure B.3: Labor Practices

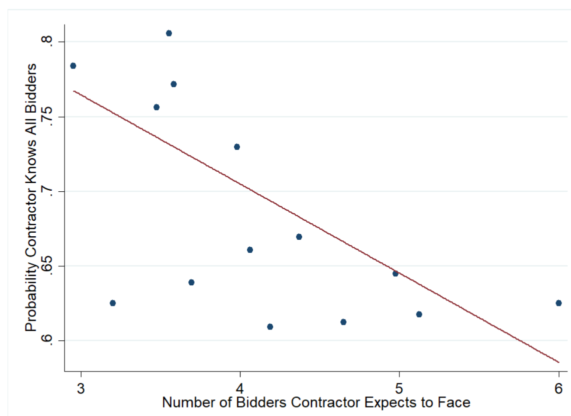


Notes: Author survey. Data aggregated to the state level. Survey available in Appendix E.

Figure B.4: Competition



(a) Stated Concerns and # of Bidders

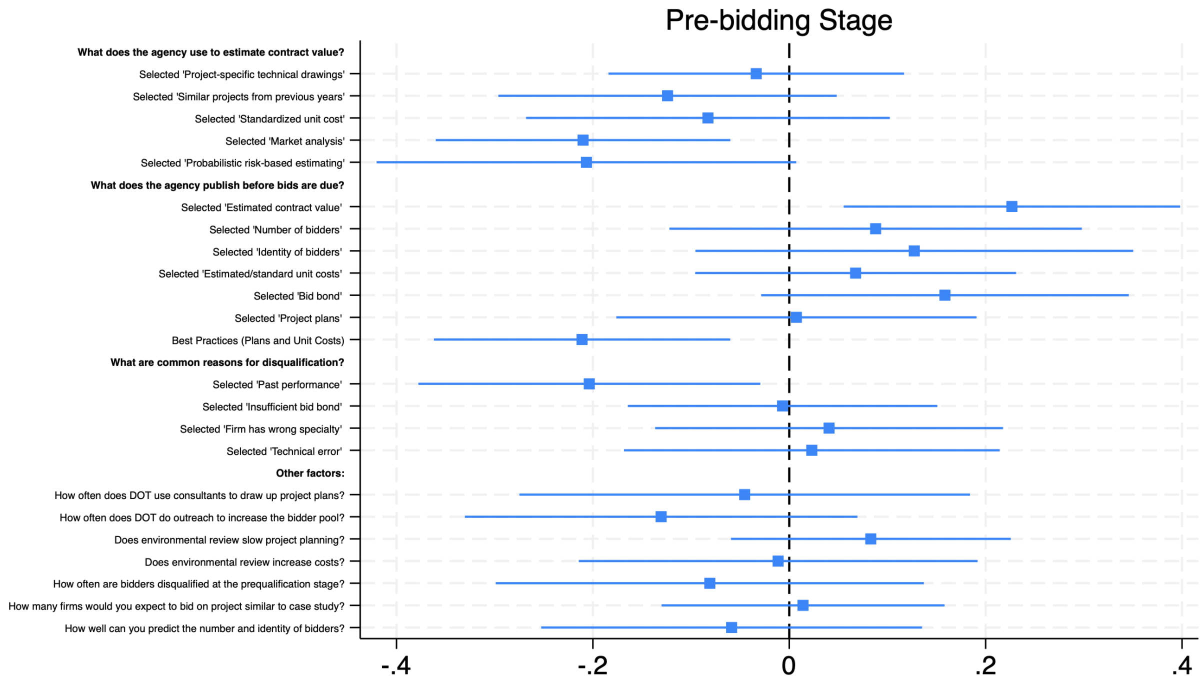


(b) Bidding Behavior

Notes: The panel on the left shows a binned scatter plot with the mention of competition as a concern on the y-axis and the number of bidders a contractor expects to face on the x-axis. This data is from the author survey, and responses are aggregated to the state level by taking the average. The panel on the right shows a binned scatter plot with the probability the contractor knows all of its competitors on the y-axis, and number of bidders on the x-axis.

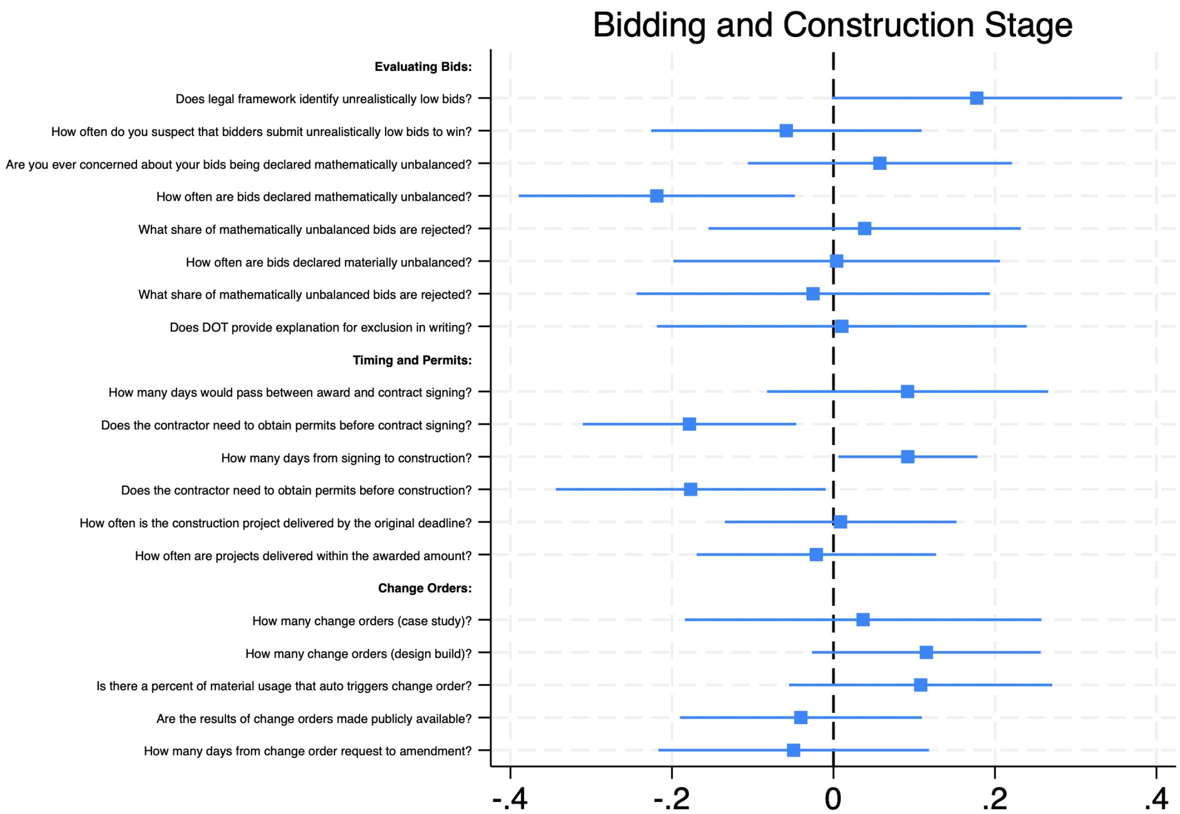
B.1 Procurement and Project Duration

Figure B.5: Survey Correlates with Project Duration: Pre-Bidding



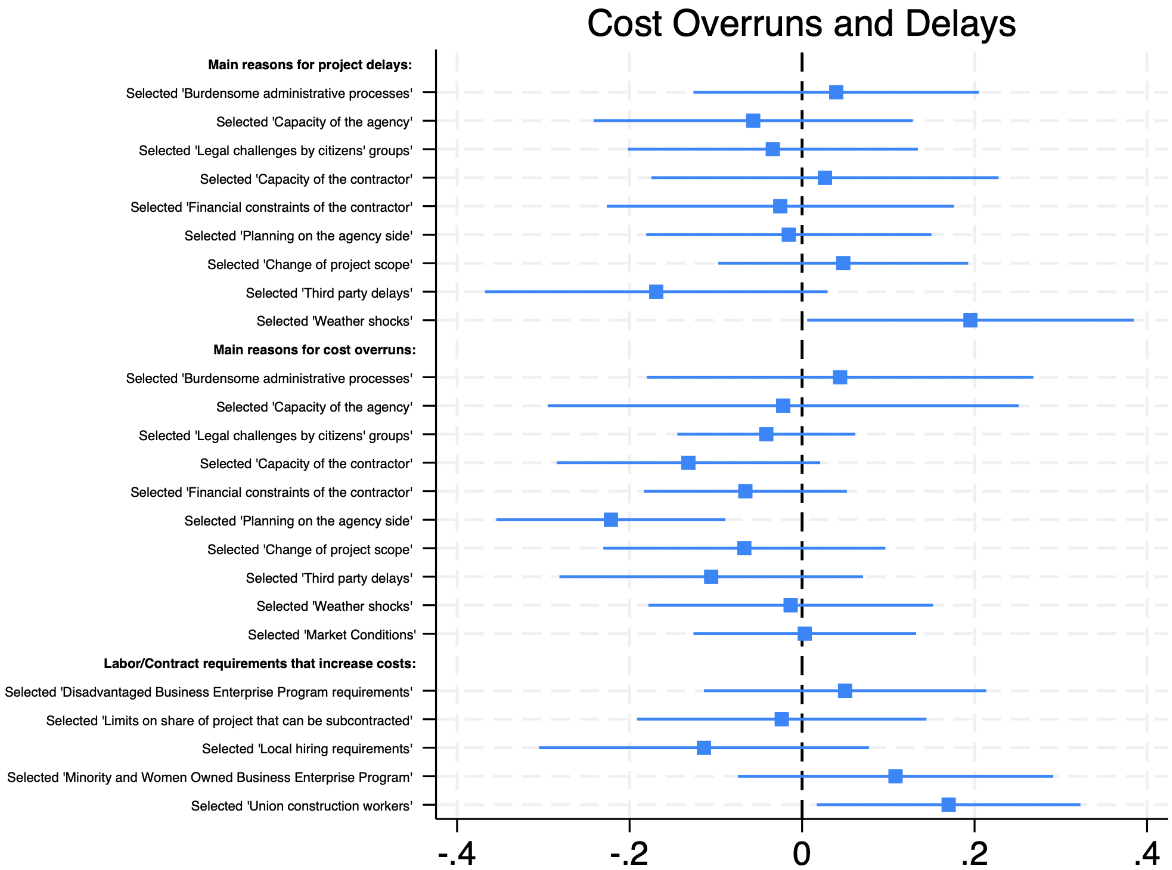
Notes: This figure shows the correlation coefficients between the survey responses and the project duration for the pre-bidding stage of the procurement process. The dependent variable is log days per lane-mile. Regressions include controls for project, local, and weather observables (per Column (3) of Table 1), and cluster standard errors at the state level. The survey responses from the procurement officials and the contractors are aggregated to a state-level average, unless the question was only asked to one group. The bars represent the 95% confidence interval. Each response variable is normalized to have a mean of zero and standard deviation of one, such that correlations are comparable across questions.

Figure B.6: Survey Correlates with Project Duration: Bidding and Construction



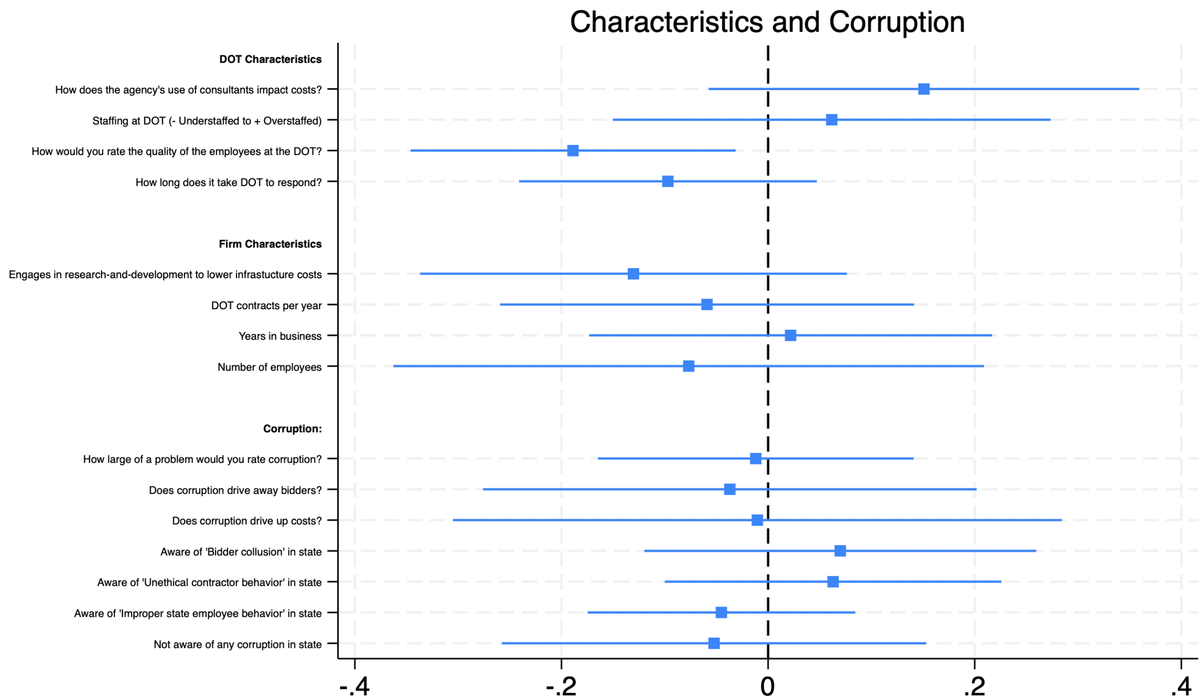
Notes: This figure shows the correlation coefficients between the survey responses and the project duration for the bidding and construction stages of the procurement process. The dependent variable is log days per lane-mile. Regressions include controls for project, local, and weather observables (per Column (3) of Table 1), and cluster standard errors at the state level. The survey responses from the procurement officials and the contractors are aggregated to a state-level average, unless the question was only asked to one group. The bars represent the 95% confidence interval. Each response variable is normalized to have a mean of zero and standard deviation of one, such that correlations are comparable across questions.

Figure B.7: Survey Correlates with Project Duration: Overruns and Delays



Notes: This figure shows the correlation coefficients between the survey responses and the project duration for the questions about cost overruns, delays, and labor costs. The dependent variable is log days per lane-mile. Regressions include controls for project, local, and weather observables (per Column (3) of Table 1), and cluster standard errors at the state level. The survey responses from the procurement officials and the contractors are aggregated to a state-level average, unless the question was only asked to one group. The bars represent the 95% confidence interval. Each response variable is normalized to have a mean of zero and standard deviation of one, such that correlations are comparable across questions.

Figure B.8: Survey Correlates with Project Duration: Other Factors



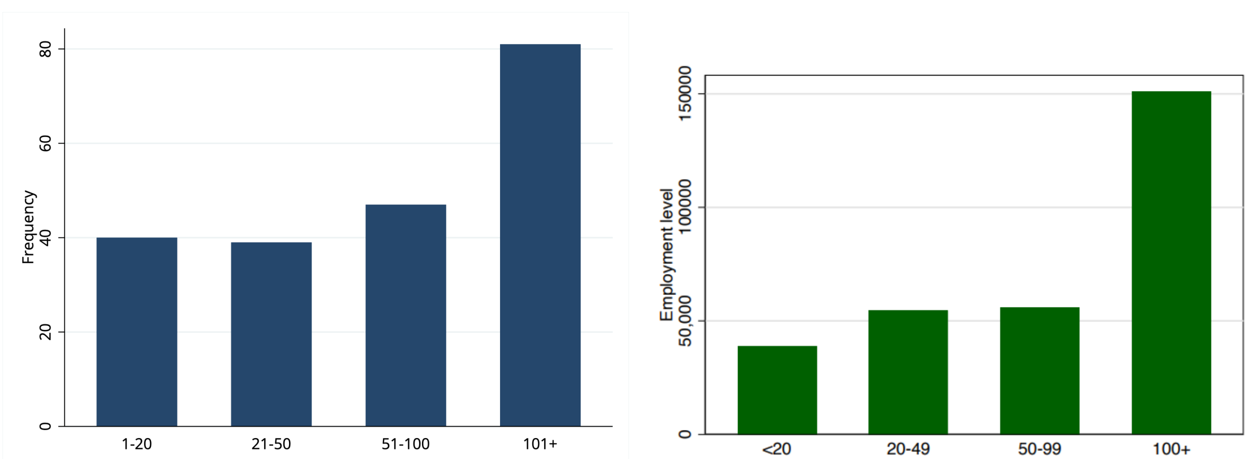
Notes: This figure shows the correlation coefficients between the survey responses and the project duration for the questions about DOT and Contractor characteristics and corruption. The dependent variable is log days per lane-mile. Regressions include controls for project, local, and weather observables (per Column (3) of Table 1), and cluster standard errors at the state level. The survey responses from the procurement officials and the contractors are aggregated to a state-level average, unless the question was only asked to one group. The bars represent the 95% confidence interval. Each response variable is normalized to have a mean of zero and standard deviation of one, such that correlations are comparable across questions.

C Contractor Characteristics

In the contractor survey we ask about the identity and characteristics of the firm: number of employees, number of years in business, and number of contracts with the state DOT. We note that the sample of contractors looks similar to the distribution of contracting firms in the U.S. by employment (Figure C.1).

We analyze whether firm characteristics correlate with certain responses to questions. A handful of interesting patterns emerge. First, respondents from larger and more experienced firms are less likely say that that corruption occurs or is a problem. These characteristics all correlate with lower values assigned to the question, "How large of a problem would you rate corruption;" the result is statistically significant for number of years in business and number of contracts. Second, respondents from larger (in terms of employees and contracts) and more experienced firms are also significantly more likely to select "planning on agency side" as a source of cost overrun. Third, respondents from firms with more years in business expect more firms to bid on projects, perhaps suggesting that the number of bidders has decreased throughout time. This is directly related to the procurement officials responses about the lack of competition, and will be a hypothesis we explore further as we collect more data.

Figure C.1: Size Distribution of Contracting Firms



(a) Our Survey (b) 2021 QCEW

D Non-Procurement Observables

D.1 Weather

We collect data on several observable characteristics of states that may be linked to elevated road maintenance costs. The first set is environmental variables, which we download from the NOAA Centers for Environmental Information and average across the years 2000-2019: winter low temperatures, summer high temperatures, and precipitation levels. The first two variables are designed to capture the prevalence of extreme cold or heat, both of which of which cause asphalt deterioration. Precipitation also causes roads to deteriorate more quickly. The NOAA does not have state-level data for snowfall, so to proxy for snowfall levels, we multiply average precipitation by the inverse of average winter low temperature.

Table 1 shows that these observables explain little of the state-level variation in costs. When included as additional controls along with our survey data in the cost analysis, none reach statistical significance. When included along with our survey data in a Lasso regression, all coefficients on state observables shrink to zero. The only observable that shows evidence for explaining some cost variation is average winter low temperature, which has a significant negative bivariate correlation with spending. This is concerning, and motivation our data collection effort for project-level cost data.

D.2 Market Structure

We take data from the Economic Census for Construction in 2007, 2012, and 2017. This dataset provides state level employment, payroll, revenues, and cost for all construction industries, including "Highway, Street, and Bridge Construction" (NAICS 23730). We use this data to create state level variables on labor costs (construction worker payroll/employment), number of establishments, and establishment size (employees per establishment). Unfortunately, for the smallest states the number of establishments is censored so we lose two states when we include these controls in Table 1.

We also have data from publicly available DBE directories. This gives us the name, address, and NAICS industry code for every firm registered with the state DOT as a DBE. We match the zip codes to commuting zones in order to create a commuting zone measure.

D.3 Public Sector Employment

We have data from the Annual Survey of Public Employment and Payroll (ASPEP), which is produced by the Census Bureau. This includes statistics on the number of state and local government civilian employees and their payrolls in March. We take employment for the "Highways" category in each state as our proxy for DOT employment. Our measure of DOT capacity is the state "Highways" employment from ASPEP, over the employment in Highway Construction from the Census of Services.

E Survey

The contractor survey is attached following this page. The procurement official survey is similar, see `https://law.yale.edu/zachary-liscow` for a link.

Thank you for making time to complete this survey, which we are conducting to study the relationship between the practices of state departments of transportation, contractors, and the cost of infrastructure procurement. Through it, we hope to learn more about one of the crucial issues in transportation today: what drives up infrastructure construction costs.

You are receiving this survey because you are a contractor with experience working with the state or local DOT. We are asking these questions to contractors across all states.

Please answer as many questions as you can, and omit those that do not apply to you. Note that we may follow up with you using the contact information you provide.

If you are comfortable, please forward the survey to others who you think would be able to answer the questions you are unable to answer.

Your information will be kept strictly confidential, identified only as being about a particular state.

This research project is being conducted by Zach Liscow (zachary.liscow@yale.edu) of Yale University, and William Nober (w.nober@columbia.edu) and Cailin Slattery (cailin.slattery@columbia.edu) of Columbia University. Please address any questions about the survey or the associated research project to Zach Liscow (zachary.liscow@yale.edu).

This research project is being supported by the US Department of Transportation through a research grant to the National Bureau of Economic Research. Thanks again for sharing your expertise here.

By completing this survey, you are consenting to participate in this study.

Contributor Information

1. Your name:	
2. Phone number:	
3. Email:	
4. Job title:	
5. Primary State of Operation: 6. Secondary State(s) (if applicable):	
7. Firm name:	
8. Firm mailing address:	
9. Years of operation:	☐ 0-2 ☐ 3-5 ☐ 6-10 ☐ 11-20 ☐ More than 20
10. Number of employees:	☐ 1-20 ☐ 21-50 ☐ 51-100 ☐ 101+
11. Number of contracts with state and local DOTs in a typical year:	☐ 0-1 ☐ 2-3 ☐ 4-5 ☐ 6+
12. Opt in to receive results	☐ Yes, please email me analysis of results after data have been compiled

1. Case Study Assumptions

We developed a case study that describes a standard project. Many of the following questions will be asking about your experience with a past project comparable to it, in order to establish consistency. Please familiarize yourself with the details of the case study:

Contractor	**The contractor** is a road construction contractor that has met all the requirements to bid on contracts from the state DOT.
Contract	**The contractor** has recently bid on and won a federal-aid contract from the state DOT, referred to from here on as "**the agency**." The project entails resurfacing 5 mi of a flat two-lane road that is part of the National Highway System (but is not an Interstate), extending from the outskirts of a medium-sized (approximately 100,000-person) city into the surrounding rural area, with an asphalt overlay of 1 inch. The estimated value of the contract is between $1-5 million.
Procurement Process	The competitive bidding was awarded using the traditional Design-Bid-Build (low-bid) process. The project is not design-build.

2. Survey

Please answer all questions to the best of your knowledge, based on your experience bidding on and completing contracts in your current primary state of operation.

1. What do you think are the main aspects of the procurement and administrative process of highway construction that increase construction costs?	
2. Which of the following most accurately describes the state department of transportation?	☐ Severely understaffed ☐ Moderately understaffed ☐ Appropriately staffed ☐ Moderately overstaffed ☐ Severely overstaffed ☐ I don't know
3. How quickly do employees at the state department of transportation get back to you when you contact them?	☐ Same day ☐ Within 48 hours ☐ Within a week ☐ Over a week ☐ I don't know
4. To the best of your knowledge, when the agency prepares to advertise a new procurement opportunity for a contract like the one described in the case study, which of the following does the agency use to estimate the contract value and projected schedule? *Select all that apply.* (a) To the best of your knowledge, how often does the agency use consultants to draw up project plans?	☐ Market analysis ☐ Standardized unit cost or deterministic cost estimation ☐ Project-specific technical drawings ☐ Feasibility study ☐ Similar projects from previous years ☐ Probabilistic risk-based estimating ☐ Other, please explain: ☐ I don't know ☐ Very rarely (less than 10% of projects) ☐ Rarely (10-25%) ☐ Occasionally (26-50%) ☐ Often (51-90%) ☐ Very often (over 90%) ☐ I don't know
5. What information does the agency publish before bids are due? *Select all that apply.*	☐ Estimated contract value ☐ Estimated/standard unit costs ☐ Bid bond ☐ Number of bidders ☐ Identity of bidders ☐ Project plans ☐ Other, please describe: ☐ I don't know
6. How many firms would you expect to bid on a project like the one described in the case study?	☐ 0-1 ☐ 2-3 ☐ 4-5 ☐ More than 5 ☐ I don't know

7. Which of the following best describes your experience regarding other companies' bidding?	☐I can usually predict exactly which firms will bid on a project ☐I know all of the firms that are capable of bidding, but not which ones actually will bid ☐I know many of the firms that might bid, but sometimes there are surprise bidders ☐There are often firms bidding that I do not know/expect ☐ Other, please describe: ☐ I don't know
8. To the best of your knowledge, what are some common reasons for disqualification in the prequalification stage? *Select all that apply.*	☐ There is no prequalification process ☐ Insufficient bid bond ☐ Past performance ☐ Technical error ☐ Firm has wrong specialty ☐ Other, please explain: ☐ I don't know
9. To the best of your knowledge, how often does the agency do outreach to increase the bidder pool for highway construction projects?	☐ Never ☐ Very rarely (1-10% of bids) ☐ Rarely (10-25%) ☐ Occasionally (26-50%) ☐ Often (51-90%) ☐ Very often (over 90%) ☐ I don't know
10. Are you ever concerned about your bids being declared mathematically unbalanced? *Note: a mathematically unbalanced bid is one containing unit bid items which do not reflect reasonable actual costs plus a reasonable proportionate share of the bidder's anticipated profit, overhead costs, and other indirect costs.*	☐ No, because we set our unit bids close to our actual costs. ☐ No, because the agency rarely declares bids mathematically unbalanced. ☐ Yes, on some bids. ☐ Yes, on most bids. ☐ Other, please specify ☐ I don't know
11. When a bidder is **excluded** before the contract is awarded, does the state DOT provide an explanation of the reasons for the exclusion in writing?	☐ Yes, always ☐ Yes, but only upon request of the bidder ☐ No, the excluded bidder will be notified directly in the contract award ☐ Other (please explain) ☐ I don't know
12. For a contract like the one described in the case study, how many days would pass on average **between public notice of award and contract signing**? *Please include the time for the winner to submit relevant documents and the time to sign the contract.*	Number of days: ☐ I don't know
13. Does the contractor need to obtain work permits or other administrative authorizations **between public notice of award and contract signing**? *Please include environmental permits, occupancy permits, activity permits, etc. as applicable.*	☐ Yes, please list them: ☐ No ☐ I don't know

14. When you win a bid, typically what is it about your firm that allows you to have the lowest bid?	☐ I don’t know
15. Do you engage in research-and-development to lower your costs of producing infrastructure?	☐ Yes, please describe what you do: ☐ No ☐ I don’t know
16. In your experience, how many change orders would a contract like the one described in the case study typically have?	Please select: ☐ I don’t know
17. If the contract was for a design-build project, how many change orders would it typically have?	Please select: ☐ I don’t know
18. Are the results of change orders made publicly available?	☐ Yes, within a month ☐ Yes, in longer than a month ☐ No ☐ I don’t know
19. How many days would typically pass from the moment one of the parties requests/initiates a change order until a new contract amendment is signed?	Number of days: ☐ I don’t know
20. How often is the construction project delivered by the original deadline?	☐ Very rarely (less than 10% of projects) ☐ Rarely (10-25%) ☐ Occasionally (26-50%) ☐ Often (51-90%) ☐ Very often (over 90%) ☐ I don’t know
21. If a project is delayed, what are usually the main reasons? *Select all that apply.*	☐ Weather shocks (natural disasters, flooding, etc.) ☐ Burdensome administrative processes within the agency ☐ Capacity of the agency (staff/skills/budgetary constraints) ☐ Capacity of the contractor (technical/managerial constraints) ☐ Financial constraints of the contractor ☐ Planning on the agency side (incomplete project specifications, etc.) ☐ Change of project scope ☐ Legal challenges by citizens’ groups ☐ Third party delays related to utilities or railroad coordination ☐ Covid-related supply shortages ☐ Other, please explain: ☐ I don’t know
22. How often are construction projects that are comparable to the case study delivered within the awarded amount?	☐ Very rarely (less than 10% of projects) ☐ Rarely (10-25%)

	☐ Occasionally (26-50%) ☐ Often (51-90%) ☐ Very often (over 90%)
23. If a project has a cost overrun, what are usually the main reasons? *Select all that apply.*	☐ Market conditions (changes in input prices, fluctuations in exchange rate, etc.) ☐ Weather shocks (natural disasters, flooding, etc.) ☐ Burdensome administrative processes within the agency ☐ Capacity of the agency (staff/skills/budgetary constraints) ☐ Capacity of the contractor (technical/managerial constraints) ☐ Financial constraints of the contractor ☐ Planning on the agency side (incomplete project specifications, etc.) ☐ Change of project scope ☐ Legal challenges by citizens' groups ☐ Third party delays related to utilities or railroad coordination ☐ Covid-related supply shortages ☐ Other, please explain: ☐ I don't know
24. For a contract like the one described in the case study, how many days would pass on average **<u>between contract signing and receipt of a notice to proceed with construction</u>**?	Number of days: ☐ I don't know
25. Does the contractor need to obtain work permits or other administrative authorizations **<u>between contract signing and receipt of a notice to proceed with construction</u>**? *Please include environmental permits, occupancy permits, activity permits, etc. as applicable.*	☐ Yes, please list them: ☐ No ☐ I don't know
26. Are there any labor and/or subcontracting requirements that increase costs?	☐ Disadvantaged Business Enterprise Program requirements ☐ Minority and Women Owned Business Enterprise Program requirements ☐ Limits on share of project that can be subcontracted ☐ Local hiring requirements ☐ Union construction workers ☐ Other: ☐ I don't know
27. How does the agency's use of third-party consultants impact construction costs?	☐ Reduces costs a large amount ☐ Reduces costs moderately ☐ No impact on costs ☐ Increases costs moderately ☐ Increases costs a large amount ☐ I don't know

28. Optional comment on how the agency's use of third-party consultants impacts construction costs:	
29. How would you rate the quality of the employees at the state department of transportation?	☐ Very low quality ☐ Moderately low quality ☐ Neither low nor high quality ☐ Moderately high quality ☐ Very high quality ☐ I don't know
30. Please describe your experience with the employees at the state department of transportation.	Please describe: ☐ Not enough experience to say
31. Are you aware of any of these types of corruption in your state? *Select all that apply.*	☐ Bidder collusion ☐ Unethical contractor behavior ☐ Improper state employee behavior ☐ Other, please describe: ☐ None of the above
32. How large of a problem would you rate corruption?	☐ Very large ☐ Somewhat large ☐ Neither large nor small ☐ Somewhat small ☐ Very small ☐ I don't know
33. Does corruption drive away bidders?	☐ Yes ☐ No ☐ I don't know Comment:
34. Does corruption drive up costs?	☐ Yes ☐ No ☐ I don't know
35. Please add any additional comments you have about corruption.	
36. Please add anything else that you would like to say about aspects of the procurement and administrative process that increase the cost that the government pays for highway construction projects.	
37. Was anything confusing about the survey? If so, please explain.	

Thank you very much for completing the survey!
We sincerely appreciate your contribution.

If you are comfortable, please forward the survey email to others who you think would be able to answer the questions you are unable to answer.