

# Procurement and Infrastructure Costs

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## 1. Infrastructure costs are substantial

- U.S. Government spent \$250B on highways in 2019 (Highway Statistics 2019)
  - \$202B on state and local highways and roads (Census 2019)
- Spending per mile has increased over time (Brooks & Liscow 2020)

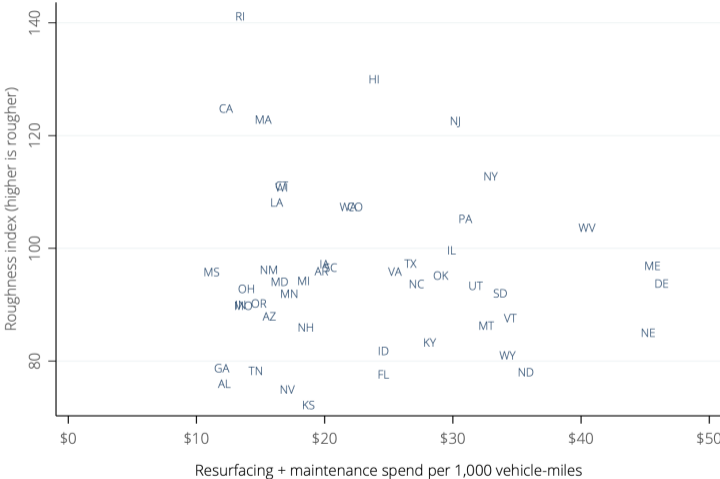
## 2. Spending varies considerably across states

## Let's look at the cost of road resurfacing across states

- Cost: Subset of Capital Outlay + Maintenance on Roads
  - Relocation, reconstruction, major widening, minor widening, restoration, rehabilitation, resurfacing
  - Inclusive (absent new roads), due to potential differences in state reporting
  - Similar exercise to Mehrotra, Turner and Uribe (2021)
- Usage: Vehicle Miles Traveled
  - Also possible to use total lane-miles
- Quality: Roughness
  - International Roughness Index (IRI)

# Striking amount of variation in cost per mile

- Mean of \$23.5, SD of \$9.6 per 1,000 vehicle miles



Source: 2014, 2018, 2019 Highway Statistics. All non-local roads.

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- The design and implementation of procurement auctions and contracts has implications for total cost of a project
  - Providing more project info to bidders ↓ costs by 5% (De Silva et al. 2008, OK DOT)
  - Providing more competitor info to bidders can facilitate collusion, increasing costs (Barrus & Scott 2020, KY DOT)
  - Incomplete contracts create costly renegotiation process (Bajari et al. 2014, Caltrans)
  - Incentives for on-time delivery ↑ welfare by 22% (Lewis & Bajari 2011, MN DOT)

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  - Incentives for on-time delivery ↑ welfare by 22% (Lewis & Bajari 2011, MN DOT)
- **No comprehensive data set on highway procurement practices across states**

# How do procurement practices affect infrastructure costs?

## **This project:**

- Conduct a 50-state survey of state DOT procurement practices
  - Based on World Bank's Doing Business Survey
  - Survey 3 groups: Procurement officers, Road engineers/Contractors, Lawyers
  - Focus where: states have discretion over practice, and potential cost drivers
- Correlate specific procurement laws and practices with cross-state data on costs
- Identify changes in laws over time → Causal estimates
  - (once we have a sense of the main cost drivers)



# Today

Developing the survey [[current draft on the conference website!](#)]

- Our approach to adopting the Doing Business survey
- Relevant case study for US context

Overview of DOT procurement process

- Links to potential cost drivers at each stage of procurement process
- Go into detail on a few key procurement steps
  - Scheduling, Prequalification, Bid screening, Renegotiation, Regulations

Next Steps

- Distribution of survey
- Eager for feedback!

## Developing the survey

The World Bank “Doing Business” Survey (Bosio et al. 2020)

- Survey of procurement officers, road builders, and lawyers in 187 countries
- 74 questions on rules and practices that would dictate the procurement process of an example road resurfacing project (“case study”)

## Developing the survey

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Adapt to U.S. Context

- Federal code constrains state procurement process when receiving federal aid
  - \$ from Highway Trust Fund; Federal share of most projects  $\sim 80\%$
  - Read code (Title 23) to determine where states have discretion
- Collect data on DOT projects across states
  - What is the modal DOT project for case study?
- Shorten survey, link to specific hypotheses about costs
  - 31 questions, some subset asked to each type of participant

Incorporate feedback from contractors, procurement lawyers, etc.

## Case Study

The modal resurfacing project done by state DOTs

- 5 mile resurfacing of 2-lane highway
- Starts in outskirts of medium-sized city; extends into rural area
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Why resurfacing?

- Road building projects are more complicated, more discretion in procurement process (design-build contracts, consider quality as well as cost)
  - All states use unit bidding for resurfacing projects
- However, many states are not building new roads
  - Rehabilitation of roads [2004-2014]: 47 → 72 % of total capital outlays
  - Road expansion and new routes: 53 → 28% in same period  
(Federal Highway Administration 2019)

## State DOT procurement and cost drivers

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3. DOT evaluates the bids and the contract is awarded
  - Decides whether any bids are “unrealistically low”
4. Contractor executes the project
  - What happens with cost overruns? Renegotiation process?
  - What are the reasons for delays?
  - Regulation and permit process

# Step 1: DOT decides which projects to complete

For Federal Fiscal years October 1, 2019- September 30, 2023

## STATEWIDE TRANSPORTATION IMPROVEMENT PROGRAM



The image features three vertical panels. The left panel shows a multi-lane highway with a yellow center line and a white shoulder line, with a few cars in the distance. The middle panel shows a large, modern steel truss bridge with two prominent arches over a body of water. The right panel shows a blue MTA bus with 'EMPIRE STATE PLAZA' on its destination sign and 'MTA Ride' on its front.



NEW YORK  
STATE OF OPPORTUNITY.

Department of  
Transportation

# Potential Cost Driver: Capacity Constraints

## Hypothesis:

- The scheduling and timing of highway procurement opportunities can drive costs
  - Contractors may be capacity constrained, costs increase for additional projects (Jofre-Bonet & Pesendorfer 2003)
  - Competitors may bid less aggressively if rivals are constrained (Balat 2012)

## Survey Questions:

**DOT** Are there limits on how many projects the agency can let in a given time period?

**Firm** How often do you bid on a new project when you have ongoing projects with the DOT?

- When you bid on a new project and you have ongoing projects with the DOT, does your bidding strategy change?

## Step 2: DOT announces the project

Colorado Department Of Transportation  
Notice To Contractors

Printed On: 09/20/2021

Read Order No. 002

Letting Date: October 14, 2021 10:00 AM

Region: 4

Counties: WELD

Contract ID: C24244

Projects: STA052A-056

Contract UDBE Goal: 5.00 %

Guaranty: 5% of Total Bid

For Plans and Specs go to <http://cdot.dbesystem.com>

Work Days: 75

Res. 4640 LOUIS EDWARD KEEN 970-350-2228

Contract Description:

This project is located at CO52 prospect valley within Weld County, CO. The work includes resurfacing CO52 between milepost 42 and 44 with full depth reclamation and HMA overlay. However, full depth reconstruction will be applied where maintaining existing grade is required. The project also includes one major CBC replacement at CO52 MP42.7 and one minor CBC replacement at CO79 MP20.08. PE stamped subsurface utility sheets are included in the bid plan.

Please register at [cdot.dbesystem.com](http://cdot.dbesystem.com) where plans and specs can be found in the "my bid solicitations" menu.

9/23/2021

One Publication: 9/23/2021

It is estimated that the total cost of all items in the bid will be:

Between \$0 and \$1,000,000

Between \$1,000,000 and \$5,000,000

Between \$5,000,000 and \$20,000,000

Greater than \$20,000,000

And provides information on quantity

# Potential Cost Driver: Prequalification

## Hypothesis:

- If the prequalification process is too complicated or arduous, competition could be artificially reduced
  - Bidders may be disqualified for small technical errors (Best et al. 2019)
  - Contractors may have to submit bid bonds and state may audit bid bond capacity

## Survey Questions:

- All After the bid advertisement, can the agency require bidders to participate in a prequalification process specific to that contract before being able to submit their economic offer?
- All How often are bidders disqualified at the prequalification stage?
- All What are some common reasons for disqualification in the prequalification stage?

# Step 3: DOT evaluates the bids and the contract is awarded

Oman Systems, Inc

## ARKANSAS BY JOB REPORT

<b>Job No:</b> 061084	<b>County:</b> HOT SPRING	<b>100</b>		
<b>Low Bidder:</b> ROBERTSON CONTRACTORS, INC.			<b>Low Bid:</b> \$7,045,842.59	<b>Letting:</b> 01/1

PayItem	Description	Quantity	Unit	1st Bidder	2nd Bidder	3rd Bidder	4th Bidder	State Average
				ROBERTSON CONTRACTORS, INC.	MANHATTAN ROAD & BRIDGE CO.	KIEWIT INFRASTRUCTURE SO. CO.	MOBLEY CONTRACTORS, INC.	
201011	CLEARING	25.000	STA-M	\$800.00	\$1,428.00	\$3,500.00	\$1,320.00	\$1,318.16
201111	GRUBBING	25.000	STA-M	\$800.00	\$1,428.00	\$3,500.00	\$880.00	\$903.49
401011	TACK COAT	406.000	GAL	\$3.50	\$3.50	\$3.50	\$3.68	\$2.68
405161	MINERAL AGGREGATE IN ACHM BASE COURSE (1 1/2")	109.000	TON	\$74.56	\$74.56	\$74.56	\$78.29	\$59.35
405402	ASPHALT BINDER (PG 64-22) IN ACHM BASE COURSE	5.000	TON	\$120.00	\$120.00	\$120.00	\$126.00	\$205.32
406161	MINERAL AGGREGATE IN ACHM BINDER COURSE (1")	1472.000	TON	\$76.44	\$76.44	\$76.44	\$80.26	\$62.09
406402	ASPHALT BINDER (PG 64-22) IN ACHM BINDER COURSE (1") (MINIMUM BID \$120.00)	74.000	TON	\$120.00	\$120.00	\$120.00	\$126.00	\$318.00
407162	MINERAL AGGREGATE IN ACHM SURFACE COURSE (1/2")	1832.000	TON	\$78.88	\$78.88	\$78.88	\$82.82	\$65.82
407432	ASPHALT BINDER (PG 64-22) IN ACHM SURFACE COURSE (1/2") (MINIMUM BID \$120.00)	109.000	TON	\$120.00	\$120.00	\$120.00	\$126.00	\$347.13
412001	COLD MILLING ASPHALT PAVEMENT	1289.000	S.Y.	\$4.25	\$5.20	\$23.64	\$16.49	\$3.06

# Potential Cost Driver: Bid Screening

## Hypothesis:

- Unrealistically low bids can lead to higher costs ex-post
  - Bidder may lack competence or be strategically manipulating bids
  - Procuring agency needs to be able to identify unrealistically low bids (Bolontyy & Vasserman 2020; NASEM 2006)

## Survey Questions:

**DOT** Does the legal framework establish criteria to identify unrealistically low (or mathematically unbalanced) bids?




- In practice, how often are bids declared mathematically unbalanced?
- If a bid is mathematically unbalanced, how often is it rejected?
- If a bid is declared materially unbalanced, how often is it rejected?

**Firm** After looking at the engineer's estimate (EE) of unit costs, which of the following most accurately describes how you would make your unit bids?





# Step 4: Contractor executes the project

HWP RESURFACING SEGMENTS OF ROUTES 120, 128, 100B: WESTCHESTER COUNTY  
Project ID No. 881522 , Contract Number D264251

## Project Schedule





Award of Contract	Original Contract Completion Date*	Substantially Completed	Construction Schedule Variance from Contract Award**
07/06/2020	11/20/2020	12/11/2020	 On-Time (Green)
<p>** This contract schedule has been adjusted as a result of a delay of Contract Award. This adjustment is excluded from the calculated Schedule Variance.</p> <p>** Schedule Variance Key:</p> <div style="border: 1px solid black; padding: 5px;"> <p> Red - Current Schedule Variance is &gt; 10% of Original Completion</p> <p> Yellow - Current Schedule Variance is &gt; 5% and &lt;=10% of Original Completion</p> <p> Green - Current Schedule Variance is within 5% of Original Completion</p> </div>			

## Construction Costs





Contract Award Cost	Approved Cost Changes	Current Construction Contract Cost	Cost Variance of Construction Contract**
\$5,029,000	-\$378,762	\$4,650,238	 On-Budget (Green)
<p>**Cost Variance Key:</p> <div style="border: 1px solid black; padding: 5px;"> <p> Red - Current Construction Costs are &gt; 10% of Contract Award Cost</p> <p> Yellow - Current Construction Costs &gt; 5% and &lt;=10% of Contract Award Cost</p> <p> Green - Current Construction Costs are within 5% of Contract Award Cost</p> </div>			

SR 5:PAVE REHAB AND SAFETY IMPROVE: STROUD ST TO HUBBARD PL  
Project ID No. 280604 , Contract Number D264135

## Project Schedule

Award of Contract	Original Contract Completion Date*	Substantially Completed	Construction Schedule Variance from Contract Award**
03/27/2020	12/31/2020	06/07/2021	 Red
<p>** Schedule Variance Key:</p> <div style="border: 1px solid black; padding: 5px;"> <p> Red - Current Schedule Variance is &gt; 10% of Original Completion</p> <p> Yellow - Current Schedule Variance is &gt; 5% and &lt;=10% of Original Completion</p> <p> Green - Current Schedule Variance is within 5% of Original Completion</p> </div>			

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Contract Award Cost	Approved Cost Changes	Current Construction Contract Cost	Cost Variance of Construction Contract**
\$2,527,024	\$228,149	\$2,755,173	 Yellow
<p>**Cost Variance Key:</p> <div style="border: 1px solid black; padding: 5px;"> <p> Red - Current Construction Costs are &gt; 10% of Contract Award Cost</p> <p> Yellow - Current Construction Costs &gt; 5% and &lt;=10% of Contract Award Cost</p> <p> Green - Current Construction Costs are within 5% of Contract Award Cost</p> </div>			



# Potential Cost Driver: Renegotiation (“change orders”)

## Hypothesis:

- Incomplete contracts can create a costly renegotiation process
  - Bidders might take advantage in the bidding stage (Ryan 2020; Bajari et al. 2014)

## Survey Questions:

- All How often would a contract like the one described in [case study] have a change order?
- All Is there a percentage of price increase below which the procuring entity is not required to provide a reason for a change?
- All In practice, are the results of change orders made publicly available?
  - How many days would pass on average from the moment one of the parties requests/initiates a change order until a new contract amendment is signed?
- DOT How often do bidders submit unrealistically low bids to win the contract, confident of having a possibility to renegotiate at a later stage?

# Potential Cost Driver: Regulations and Permits

## Hypothesis:

- Environmental regulations and permitting can increase costs
  - Evidence from federal-aid highway construction (Smith et al. 1999)
  - Construction firms aware of regulations may bid higher (Tarrer et al. 1995)

## Survey Questions:

- All In practice, how many days would pass on average between public notice of award and contract signing?
- 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.*
  - If “Yes”, how many days out of the total time you indicated are devoted to obtaining such permits/authorizations?

## Next Steps: Distributing the survey

Need to reach both procurement officials and contractors

- And, importantly, get them to engage with the survey

Strategy: Partner with trade associations to distribute the survey

- Have membership that we want to reach
- Members accustomed to receiving emails, surveys from the association
- Contractors: ARTBA; Procurement Officials: NASPO, AASHTO

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*Open to other leads!*

Draft survey on conference site,  
feedback welcome!

# DOT provides estimate of quantity for each item needed

Item No.	Description	Quantity	Units
201-00000	Clearing and Grubbing	1,000	L S
202-00027	Removal of Riprap	152,000	SY
202-00220	Removal of Asphalt Mat	9,427,000	SY
203-00010	Unclassified Excavation (Complete In Place)	8,904,000	CY
206-00000	Structure Excavation	1,767,000	CY
207-00700	Topsoil (Onsite)	3,227,000	CY
207-00704	Subgrade Soil Preparation	21,780,000	SY
208-00008	Erosion Log Type 2 (12 Inch)	2,900,000	LF
208-00106	Sweeping (Sediment Removal)	144,000	HOUR
213-00012	Spray-on Mulch Blanket	4,000	ACRE
304-06007	Aggregate Base Course (Class 6)	2,331,000	CY
304-08002	Aggregate Base Course (Shoulder Material)	392,000	CY
310-00608	Full Depth Reclamation of Hot Mix Asphalt Pavement (0-8")	25,040,000	SY
310-00610	Full Depth Reclamation of Hot Mix Asphalt Pavement (8-12")	6,186,000	SY
403-00720	Hot Mix Asphalt (Patching) (Asphalt)	100,000	TON
403-34751	Hot Mix Asphalt (Grading SX) (75) (PG 64-28)	11,453,000	TON
420-00113	Geotextile (Drainage) (Class 2)	1,335,000	SY
506-00212	Riprap (12 inch)	718,000	CY
601-01000	Concrete Class B	2,000	CY
601-03030	Concrete Class D (Box Culvert)	43,400	CY
603-01305	30 Inch Reinforced Concrete Pipe (Complete In Place)	192,000	LF
603-05030	30 Inch Reinforced Concrete End Section	8,000	EACH
603-10180	18 Inch Corrugated Steel Pipe	41,000	LF
603-10300	30 Inch Corrugated Steel Pipe	30,000	LF
603-70604	6x4 Foot Concrete Box Culvert (Precast)	95,000	LF
603-71004	10x4 Foot Concrete Box Culvert (Precast)	156,000	LF
620-00002	Field Office (Class 2)	1,000	EACH
620-00012	Field Laboratory (Class 2)	1,000	EACH
625-00000	Construction Surveying	1,000	L S
626-00000	Mobilization	1,000	L S
627-00011	Pavement Marking Paint (Waterborne)	425,000	GAL
630-00000	Flagging	2,400,000	HOUR
630-00001	Pilot Car Operation	400,000	HOUR
630-00012	Traffic Control Management	75,000	DAY
630-80355	Portable Message Sign Panel	5,000	EACH



9/2/2021 9:59 AM

AASHTOWare Project™ Version 4.5 Revision 027

**Preliminary Bid List**

Report v1

**Call Number:** 009

**Contract ID:** 66000-207542

**Description:** 4.00 mi of hot mix asphalt crushing, shaping and resurfacing, aggregate base, guardrail and pavement markings on Gardner Road north of 1 1/2 Mile Road, Ontonagon County. This is a Local Agency Project.

**Letting Of September 03, 2021**

Vendor ID	Vendor	Contact Information
00014	Bacco Construction Company - Iron Mountain, MI	<b>Ph:</b> (906)774-2616 <b>Fax:</b> (906)774-0510
00196	Mathy Construction Company - Onalaska, WI	<b>Ph:</b> (608)783-6411 <b>Fax:</b> (608)783-4311
00987	Payne & Dolan Inc. - Gladstone, MI	<b>Ph:</b> (906)428-1008 <b>Fax:</b> (906)428-2823