# Infrastructure Costs Across the States

Ella Goeckner-Wald
UC Berkeley

Anderson Kovesci
UC Berkeley

Cailin Slattery
UC Berkeley

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# It is very expensive to build and maintain infrastructure in the U.S.

U.S. govt spent $330B on highways in 2024

- Primarily maintenance and rehabilitation

Open question of *why* it is so expensive

- Growing literature, many hypotheses: competition, capacity, procurement, regulation, politics, usage...
- How much does any one cost driver contribute to differences in costs, over time and across states?

One major roadblock is **data**

- No comprehensive data on *project-level* costs

The Pew Charitable Trusts

State and Local Governments Face Persistent Infrastructure Investment Challenges

State and local governments across the United States spend roughly half a trillion dollars annually on transportation and water...

Feb 3, 2023



Vox

Why do roads, rail, and infrastructure cost so much to build in the US?

As Congress argues over the size of the infrastructure bill and how to pay for it, very little attention is being devoted to one of the most...

Jun 28, 2021



CNN

The cost to fix America's crumbling infrastructure? Nearly $2.6 trillion, engineers say

With the money from his $1.9 trillion coronavirus relief law starting to flow, President Joe Biden is turning his attention to his next...

Mar 30, 2021



New York Magazine

Why We Can't Figure Out Why Infrastructure Is So Expensive

The GAO set about to find out why American infrastructure is so expensive, and their failure points to a problem that is going to be...

Jul 24, 2019



# This Project: Infrastructure Costs Across the States

We collect data on project-costs across all 50 states, from 2015-2025

- Based on work in Liscow, Slattery and Nober (2025)
- Sloan/NBER Grant: "Procuring, Valuing, and Financing Transportation Infrastructure"
- End product will be public data source hosted by NBER

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Today:

1. Data collection process
2. Descriptives on project costs
3. Method for categorizing projects

# Data Collection

# Data Collection

1. *FOIA Requests to 50 State DOTs for project-level data*

   key variables: project description, county, route, winning bid, realized costs

| | A | B | C | D | E | F | G | H | I | J | K | L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Project ID number | Project description | County | Route | Mileage | Bid open date | Contract award date | Construction start date | Contract completion date | Engineer's Estimate | Contract award cost | Final contract cost |
| 2 | KA 1004-02 | GRADING AND SURFACING | WALLACE | K027 | 4.299 | 1/14/2015 | 2/2/2015 | 3/5/2015 | 10/22/2016 | $ 10,575,279 | $ 9,351,421 | $10,352,728 |
| 3 | KA 2108-01 | GRADING, BRIDGE AND SURFACING | THOMAS | U083 | 0.095 | 1/14/2015 | 2/2/2015 | 4/2/2015 | 12/17/2015 | $ 1,499,398 | $ 1,713,561 | $ 1,704,646 |
| 4 | KA 2112-01 | GRADING, BRIDGE AND SURFACING | WOODSON | U054 | 0.628 | 1/14/2015 | 2/2/2015 | 3/2/2015 | 11/13/2015 | $ 4,627,340 | $ 4,101,080 | $ 4,013,411 |
| 5 | KA 2610-01 | GRADING AND SURFACING | NEMAHA | U036 | 0.721 | 1/14/2015 | 2/10/2015 | 4/20/2015 | 2/29/2016 | $ 1,329,076 | $ 1,317,202 | $ 1,280,261 |
| 7 | KA 3143-01 | INTERSECTION IMPROVEMENT | MCPHERSON | U056 | 0.088 | 1/14/2015 | 2/2/2015 | 8/10/2015 | 4/18/2016 | $ 427,676 | $ 341,916 | $ 348,013 |
| 8 | KA 3555-01 | GRADING AND SURFACING | CHEROKEE | K103 | 0.108 | 1/14/2015 | 2/10/2015 | 4/6/2015 | 3/3/2016 | $ 569,212 | $ 583,321 | $ 686,412 |
| 9 | KA 3646-01 | SURFACING | SEDGWICK | I135 | 0.25 | 1/14/2015 | 2/2/2015 | 5/10/2015 | 5/19/2015 | $ 167,920 | $ 118,952 | $ 119,319 |
| 10 | KA 3782-01 | 3.0 OVERLAY | OTTAWA | U081 | 6.668 | 1/14/2015 | 2/2/2015 | 9/8/2015 | 6/16/2016 | $ 2,666,254 | $ 2,280,640 | $ 2,197,591 |
| 11 | KA 3805-01 | PAVEMENT PATCHING | HARVEY | U050 | 3.51 | 1/14/2015 | 2/2/2015 | 4/14/2015 | 8/28/2015 | $ 2,157,147 | $ 1,590,099 | $ 1,577,270 |
| 12 | KA 3807-01 | PAVEMENT PATCHING | BUTLER | U054 | 7.49 | 1/14/2015 | 2/2/2015 | 7/20/2015 | 11/2/2015 | $ 1,407,725 | $ 1,396,434 | $ 1,775,359 |
| 13 | KA 3833-01 | CONVENTIONAL SEAL | CRAWFORD | K007 | 10.49 | 1/14/2015 | 2/2/2015 | 8/7/2015 | 5/6/2016 | $ 1,345,667 | $ 1,041,406 | $ 1,019,996 |

| | B | C | D | E | F | G | H | J | K | L |
|---|---|---|---|---|---|---|---|---|---|---|
| | Project ID numbe | Project Description | County | Route | Project Mi | Engineer Estimate | Award AMT | PD_TO_CONTRACTOR | Open Bid DT | Work Begin |
| | STP 2013(029)HES | PROVIDE ADDITIONAL PAVED SURFACE WI | GILLESPIE | RM 2721 | 0006.022 | $2,893,531.65 | $2,899,581.31 | $2,710,899.58 | 9/7/2012 | 11/26/2012 |
| | STP 2009(791) | RECONSTRUCTING AND WIDENING | EL PASO | MH | 0002.609 | $8,810,841.60 | $7,505,306.00 | $11,082,597.66 | 9/6/2012 | 7/8/2013 |
| | STP 2005(276)TEG | CONSTRUCT TWO SAFETY REST AREAS | EASTLAND | IH 20 | 0003.119 | $16,609,600.06 | $16,358,386.58 | $16,580,055.62 | 10/10/2012 | 2/1/2013 |
| | BR 2013(122) | REPLACE BRIDGE AND APPROACHES | BRAZORIA | BS 288B | 0000.481 | $8,055,200.77 | $6,891,169.85 | $7,098,917.63 | 10/10/2012 | 1/18/2013 |
| | NH 2012(641) | PROVIDE SIGNALIZED INTERSECTIONS | TRAVIS | US 290 | 0001.720 | $3,545,487.06 | $4,638,870.66 | $5,515,955.00 | 10/10/2012 | 5/14/2013 |
| | NH 2012(638) | WDN, GR, STRS & SURF | BELL | US 190 | 0005.948 | $54,946,610.79 | $55,361,501.09 | $59,135,868.25 | 10/10/2012 | 3/4/2013 |
| | STP 2013(136)MM | GR, STRS, BASE AND PAVE | HARRIS | IH 610 | 0004.301 | $108,631,270.21 | $107,046,836.41 | $118,350,358.06 | 10/9/2012 | 11/20/2012 |
| | NH 2012(474) | GR, STRS, BASE AND SURF | HARRIS | FM 529 | 0001.184 | $7,523,197.24 | $7,690,213.53 | $8,449,345.44 | 10/10/2012 | 3/15/2013 |

# Data Collection

2. *Download online results from bid lettings*

   key variables: all bidder names and bids

Connecticut Department Of Transportation — 7/10/2024

Vendor Ranking — Page 1 of 2

**Call Order:** 001 **Contract ID:** 0037-0103-R1 **Counties:** Middlesex
**Letting Date:** July 10, 2024 2:00 pm **District(s):** District 1 - Rocky Hill
**Advertised on:** 5/22/2024 12:00:00 AM **Contract Time:** 348 CALENDAR DAYS **Min:** **Max:**

**Contract Description:** Replace of Bridge # 02442 Durham Route 68 over Sawmill Brook **Project(s):** 0068(122)

| Rank | Vendor Name | Total Bid | Percent Of Low Bid |
|---|---|---|---|
| 1 | New England Road Inc | $1,861,208.00 | 100.00% |
| 2 | Dayton Construction Company Inc | $1,927,727.00 | 103.57% |
| 3 | Brunalli Construction Company | $1,979,550.00 | 106.36% |
| 4 | NJR Construction LLC | $2,213,444.00 | 118.93% |
| 5 | ROTHA Contracting Company Inc | $2,225,976.60 | 119.60% |
| 6 | Xenelis Construction Company Incorporated | $2,244,160.00 | 120.58% |
| 7 | Loureiro Contractors Inc | $2,794,953.00 | 150.17% |
| 8 | Northern Construction Service LLC | $3,264,164.00 | 175.38% |
| 9 | Empire Paving Inc | $3,333,322.50 | 179.09% |

DATE: 04/22/13 ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEP
BID TABULATION SUMMARY

BIDS OPENED FOR JOB BB0105 LETTING DATE: 04/17/13

NHPP-STPR-40-5(153)240 & 9050

COUNTY: ST. FRANCIS

JOB NAME: FORREST CITY-EAST (F)

LENGTH: 7.876 MILES

ROUTES: 40
SECTIONS: 51

AMOUNT FOR AWARD CONSIDERATION (PER JOB SPECIAL PROVISION "SITE USE (A+C METHOD)")

| RANK | VENDOR NO./NAME | | TOTAL BID | DAYS BID | AMOUNT FOR AWARD CONSIDERATION (TOTAL BID + DAYS BID * $100,000) |
|---|---|---|---|---|---|
| 1 | APAC40 | APAC-TENNESSEE, INC. | $ 51,946,709.12 | 140 | $ 65,946,709.12 |
| 2 | KOSS10 | KOSS CONSTRUCTION CO. | $ 55,991,218.76 | 112 | $ 67,191,218.76 |
| 3 | KIEW15 | KIEWIT INFRASTRUCTURE SOUTH CO. | $ 58,928,314.54 | 85 | $ 67,428,314.54 |
| 4 | REDS10 | REDSTONE CONST. GROUP, INC. | $ 57,674,701.76 | 120 | $ 69,674,701.76 |

# Data Collection

3. *Collect itemized bid tabs (online and FOIA)*

   key variables: all items, quantities and bids

| LINE NO / ITEM CODE / ALT<br>ITEM DESCRIPTION | QUANTITY | ( 0 )<br>ENGINEER'S ESTIMATE<br>UNIT PRICE | <br><br>AMOUNT | ( 1 )<br>ALLAN MYERS MD INC<br>UNIT PRICE | <br><br>AMOUNT | ( 2 )<br>A-DEL CONSTRUCTION CO INC<br>UNIT PRICE | <br><br>AMOUNT |
|---|---|---|---|---|---|---|---|
| SECTION 0001 Category 0001 | | | | | | | |
| 0010 202000<br>EXCAVATION AND EMBANKMENT | 200.000 CY | 35.00000 | 7000.00 | 75.00000 | 15000.00 | 50.00000 | 10000.00 |
| 0020 207000<br>STRUCTURAL EXCAVATION | 200.000 CY | 40.00000 | 8000.00 | 20.00000 | 4000.00 | 41.00000 | 8200.00 |
| 0030 209005<br>FURNISHING BORROW, TYPE C FOR PIPE AND UTILITY TRENCH BACKFILL | 200.000 CY | 26.00000 | 5200.00 | 30.00000 | 6000.00 | 25.00000 | 5000.00 |
| 0040 211001<br>REMOVAL OF PORTLAND CEMENT CONCRETE PAVEMENT, CURB AND SIDEWALK | 200.000 SY | 30.00000 | 6000.00 | 25.00000 | 5000.00 | 20.00000 | 4000.00 |
| 0050 301002<br>GRADED AGGREGATE BASE COURSE, TYPE B, PATCHING | 200.000 CY | 64.00000 | 12800.00 | 70.00000 | 14000.00 | 90.00000 | 18000.00 |
| 0060 301003<br>GRADED AGGREGATE BASE COURSE, TYPE B | 500.000 TON | 44.00000 | 22000.00 | 60.00000 | 30000.00 | 40.00000 | 20000.00 |
| 0070 401005<br>SUPERPAVE TYPE C, PG 64-22 (CARBONATE | 8000.000 TON | 65.00000 | 520000.00 | 72.75000 | 582000.00 | 83.00000 | 664000.00 |

# Summary: 3 data frames

**Project-level:** project description, county, route, winning bid, realized costs

→ Can track **realized costs** over time for same project type and location

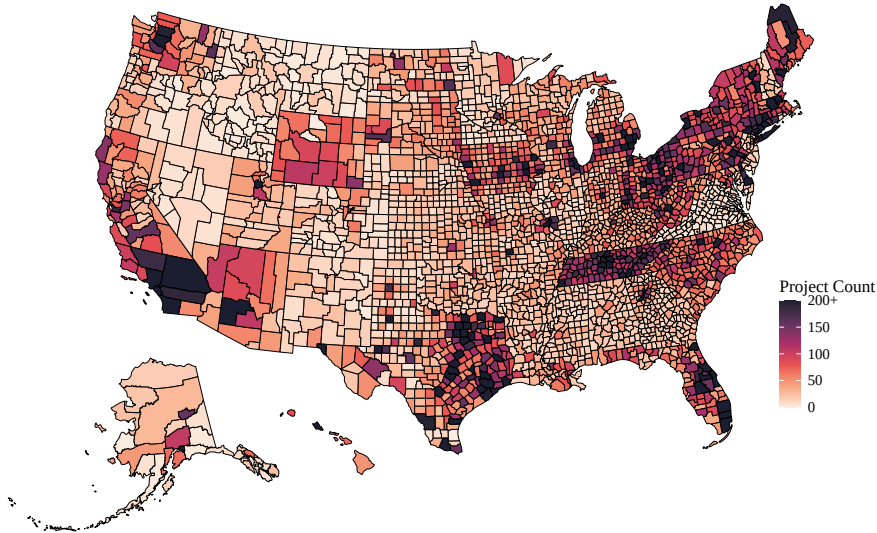
**Bidder-level:** all bidder names and bids

→ Can track **firms** across projects and space

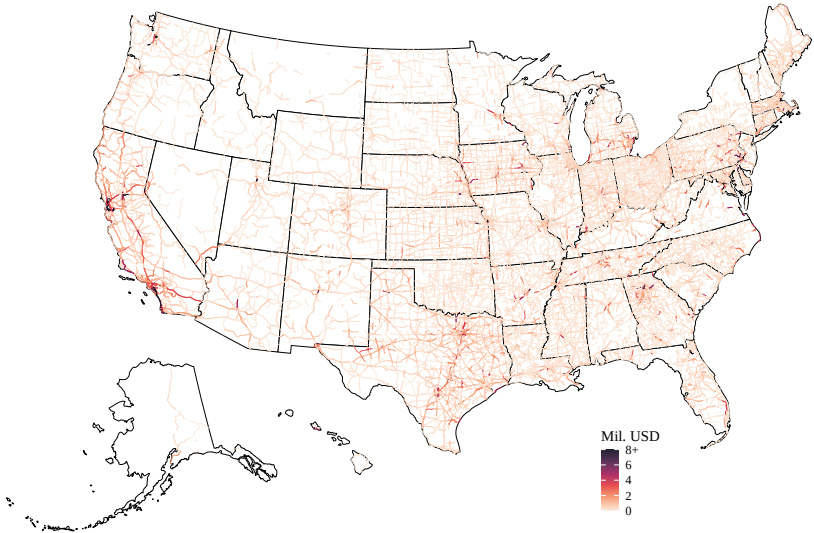
**Item-level:** all items, quantities and bids

→ Can use inputs to **categorize** projects

# Project-level data spans all 50 states



# Allows us to track spending by route



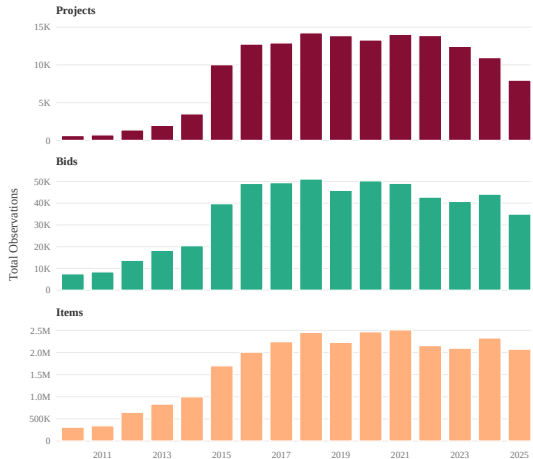
# Allows us to track spending over time

Data coverage ranges by state

- Most states span 2015-2025

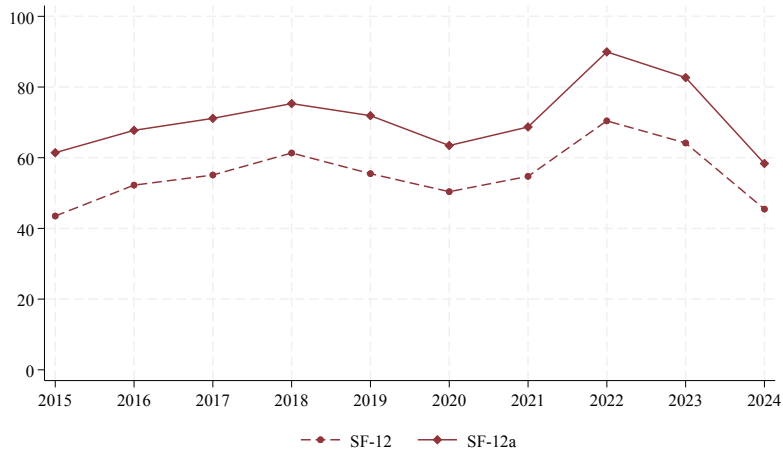
For the years of 2015-2025, we have:

- 10k-15k unique projects per year
- 40k-50k unique bids per year
- 1.5-2.5 million unique bid-items per year



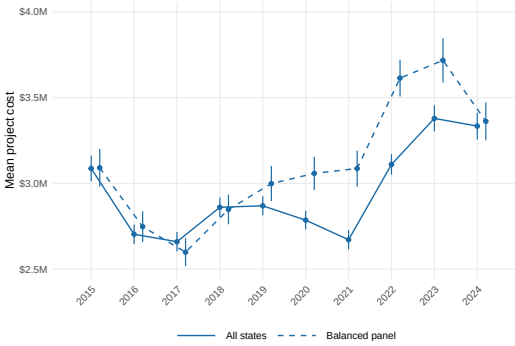
# Realized spending in our project data accounts for 60-80% in FHWA

Highway Statistics: Capital Outlay and Maintenance, less ROW, Engineering

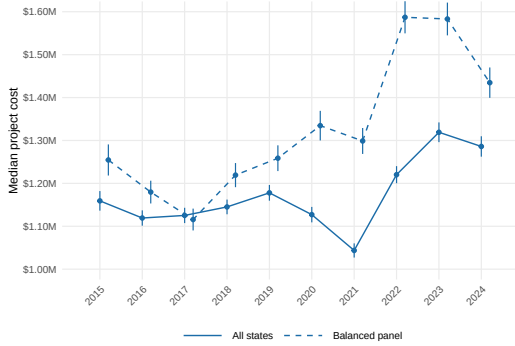


# Descriptives

# Project costs are increasing over time



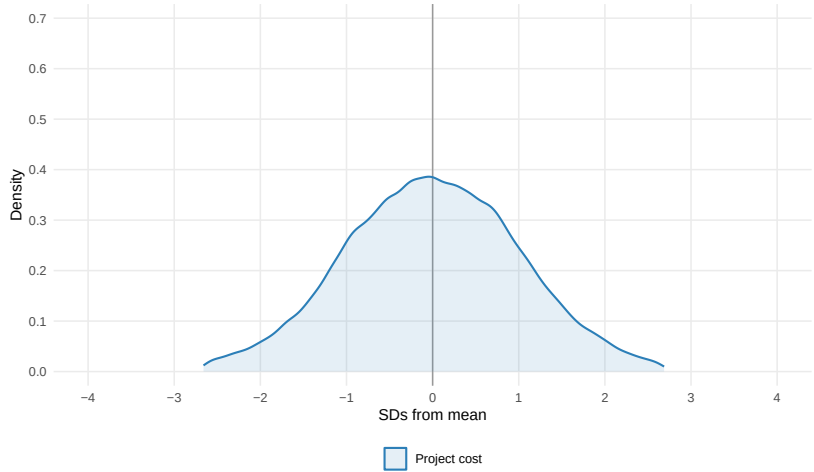

(a) Mean Project Cost ($2024)




(b) Median Project Cost ($2024)

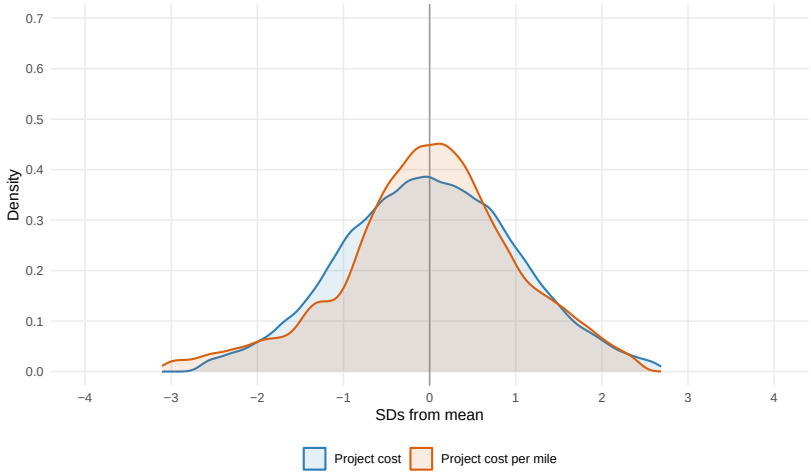
Cost per mile

# Significant variation in project costs



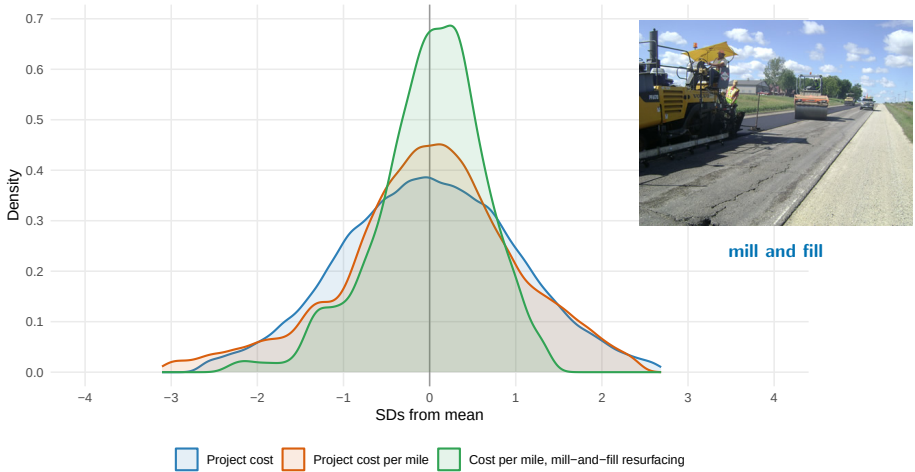

- Project costs over the sample: $2.5mil mean, $4.5mil std dev

# Distribution of project costs *per mile*




- Project costs *per mile*: \$1.2mil mean, \$2.7mil std dev

# Distribution of project costs per mile *within project type*






**mill and fill**

- Project costs per mile of *mill and fill*: $493,000 mean, $520,000 std dev Summary stats

# Categorization of Project Types

# We use the item-level data to categorize projects

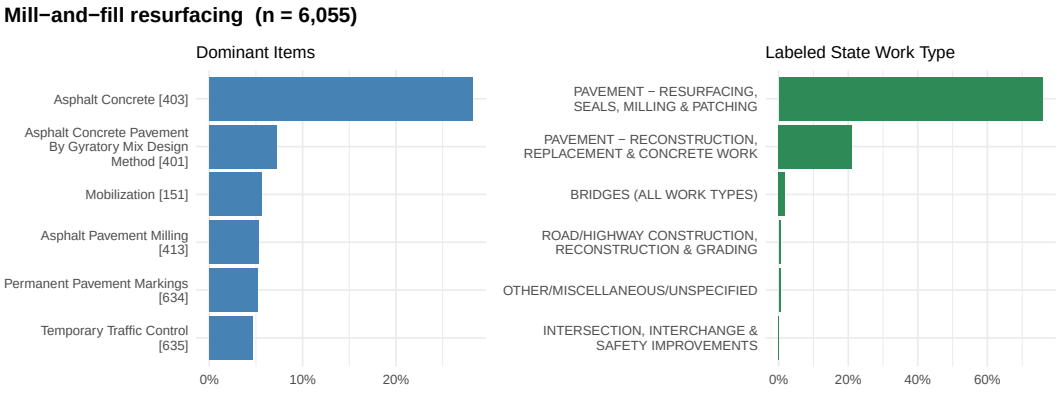
Items provide a lot of valuable information

- All of the inputs into a project
- And their relative importance as a share of total price or quantity

Our process is as follows:

1. Standardize items across states More
2. Use items to vectorize projects More
3. Apply clustering algorithm to create groups by work type More
4. Analyze & validate the categories

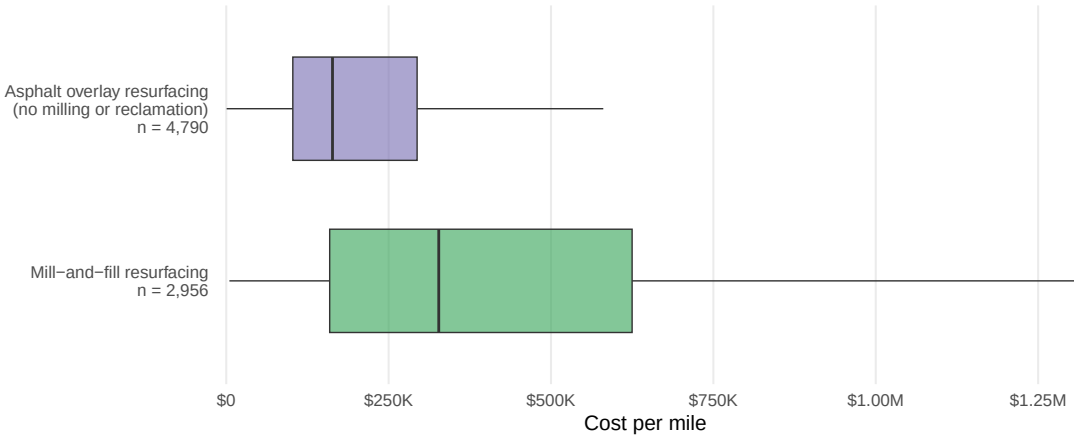
# Example: Mill and Fill



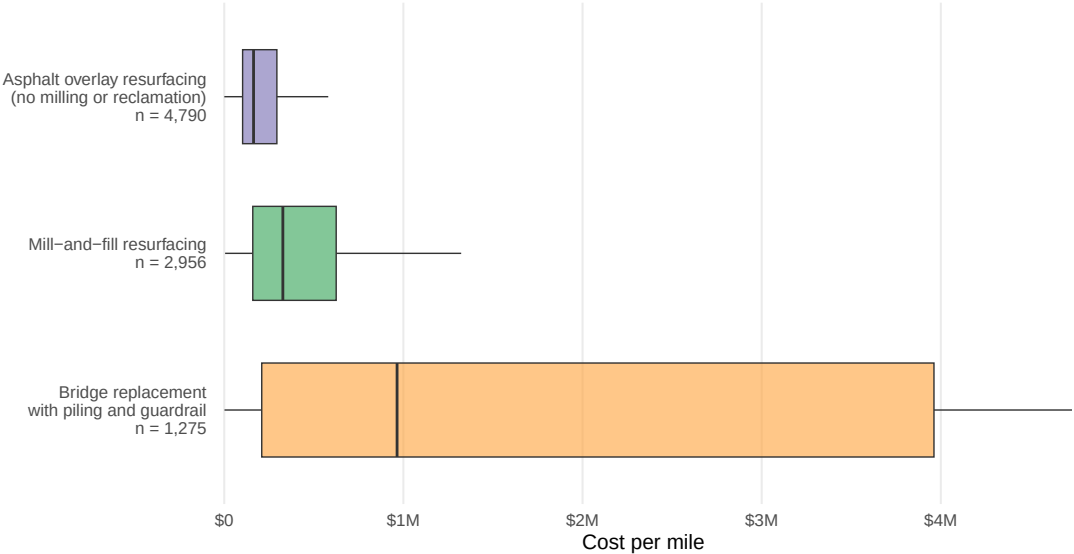

- Dominant items include asphalt concrete and milling
- In a few states we have "labeled" project data, and therefore we can see the majority of projects we categorize as "mill and fill" are labeled as "pavement: resurfacing, seals, milling & patching"

# Sanity Check

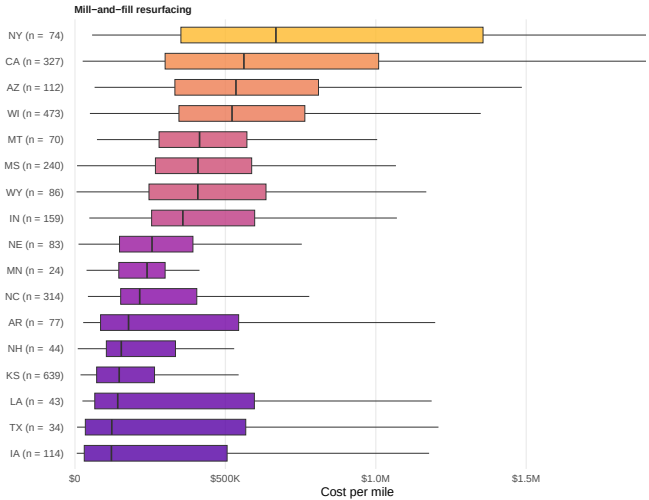
## Cost per mile higher for mill and fill than for overlay without milling...



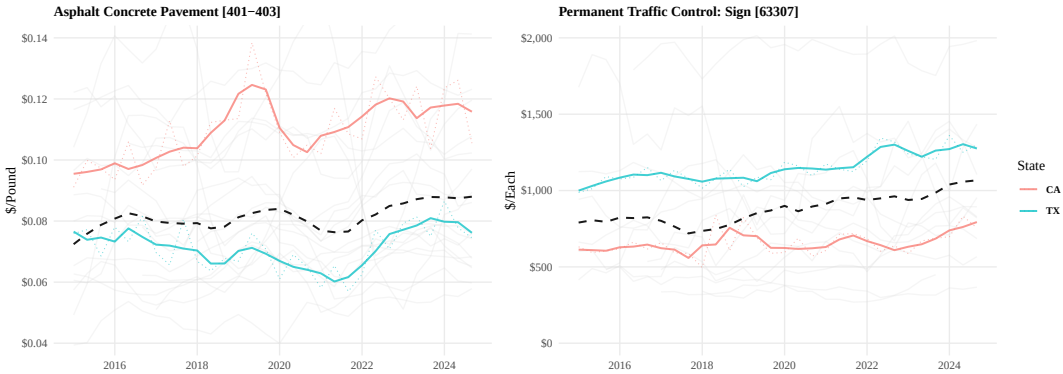
# ...and bridge replacement work is **much** more expensive



# Now we can compare cost per mile *within project type*, across states



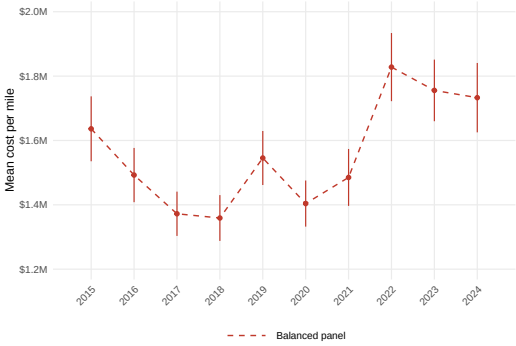
# And we can see how cost of individual *items* change in these states



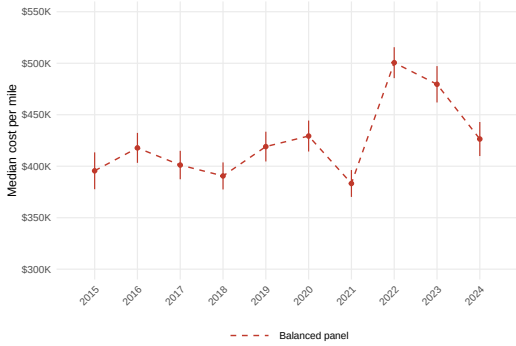
# Conclusion

- We collect comprehensive data on infrastructure projects completed by State DOTs
  - For $\sim$10 years, and 50 states
- We document significant variation in project costs across states
  - Even when looking *within* project type
- We believe this data should be useful for researchers and policymakers alike
  - Looking forward to digging in more
  - **Bonus!** Competition

# Costs per mile, also increasing, since 2021




(a) Mean Project Cost ($2024/mile)




(b) Median Project Cost ($2024/mile)

Back

# State FE do not explain much of the variation

| | Mean | SD | N | State FE $R^2$ |
|---|---|---|---|---|
| Project cost | 2,539,718 | 4,487,385 | 130,544 | 0.047 |
| Project cost per mile | 1,233,632 | 2,652,467 | 44,574 | 0.043 |
| Cost per mile, mill-and-fill resurfacing | 493,213 | 520,361 | 2,956 | 0.135 |

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# Item Standardization

Back

- *Item Descriptions*
  - We take state item descriptions and match them to modified broad (167) and fine (603) FHWA item categories
  - The process involves several stages of TF-IDF, incorporation of RA-made training data, and LLM input
- *Units, Quantities, Prices*
  - Unique units are standardized as much as possible
  - Quantities and prices are updated to reflect the new unit

*Example of our raw bidtab data which we have standardized:*

| Line No / Item ID<br>Item Description<br>Alt Set / Alt Member | Quantity and Units | (1) Ludlow Construction Co Inc<br>Unit Price | <br>Ext Amount | (2) King Construction Inc<br>Unit Price | <br>Ext Amount | (3) Spazzarini Construction Company Inc<br>Unit Price | <br>Ext Amount |
|---|---|---|---|---|---|---|---|
| SECTION: 1 | | | Cat Alt Set: | | Cat Alt Member: | | |
| 0840 1211001 | 100.000 | 1.70000 | 170.00 | 1.75000 | 175.00 | 2.00000 | 200.00 |
| REMOVAL OF PAVEMENT MARKINGS | s.f. | | | | | | |
| 0850 1212001 | 500.000 | 2.00000 | 1,000.00 | 2.00000 | 1,000.00 | 4.00000 | 2,000.00 |
| TEMPORARY PLASTIC PAVEMENT MARKING TAPE - 4" YELLOW | l.f. | | | | | | |

# Clustering: Existing Approaches

Back

Foundational papers vectorize projects with items and apply clustering algorithms to create groups by work type

- Cost Composition Vectors:

**Quantifying the Similarity between Different Project Types Based on Their Pay Item Compositions: Application to Bundling**

Yu Qiao[1]; Jon D. Fricker, M.ASCE[2]; and Samuel Labi, M.ASCE[3]

- Cost Composition Vectors with TF-IDF Item Similarity Weight:

**Cost-Weighted TF-IDF: A Novel Approach for Measuring Highway Project Similarity Based on Pay Items' Cost Composition and Term Frequency**

Quan Do[1]; Muhammad Ali Moriyani, S.M.ASCE[2]; Chau Le, A.M.ASCE[3]; and Tuyen Le, A.M.ASCE[4]

- Quantity Composition Vectors with TF-IDF Item Similarity Weight:

**Enhanced Highway Project Clustering Framework to Support Project Cost Estimation**

Quan Do, S.M.ASCE[1]; Muhammad Ali Moriyani, S.M.ASCE[2]; Tuyen Le, A.M.ASCE[3]; Chau Le, A.M.ASCE[4]; and Kalyan Piratla, A.M.ASCE[5]

# Clustering: Our Approach

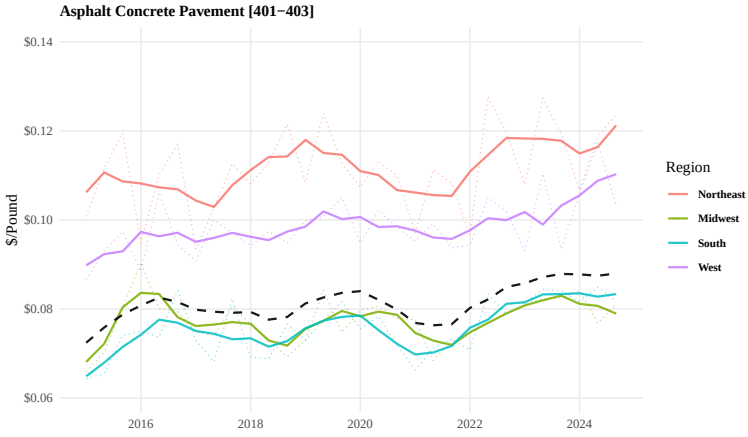
Back

All previous work focuses on one state at a time; Our approach creates categories across states

- A few sources of bias arise when clustering across states:
  - *To limit large state bias:* We cluster on a sample of max 1000 projects per state
  - *To limit complex project bias:* Rank-based vectors and unit normalization
  - *To account for item similarity:* We utilize a soft cosine similarity distance (Sidorov, Grigori, et al., 2014)

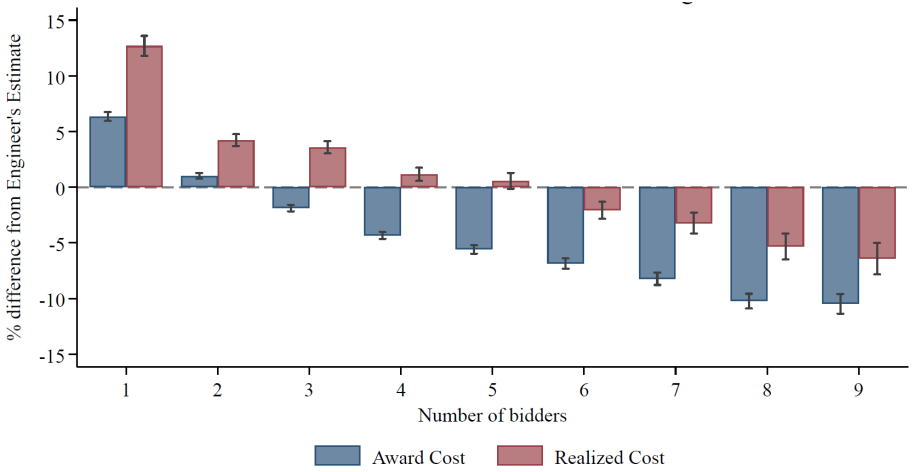
- We apply the above to cost-based and quantity-based vectors
  - i.e., you can weight by cost share or quantity share of each item

# Cost per item by region




Back

# Competition: Costs relative to the engineer estimate




- Realized and award costs, relative to estimates, decrease with the amount of competition Back

# Competition: Bidders over time

