PA USTIF Competitive Bidding Research Update

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Today

Current Analysis Results

a) Claim Denials

b) Closed Claims (Costs and Durations)

c) Describe the state of Competitive Bidding

   i. How does a claim end up in a Competitive Bidding contract?

Highlight Extensions

a) What are the gains from improving the Claims ➔ Auction system?

What is the Unit of Analysis?

Facility-Claims

A facility-claim is built from

- PA DEPs UST Public and Private UST databases (Thank you Josh Blanco!)
  - All Tank component for all facilities in PA
- USTIF Claims (contracts and claims) datasets
- **eFacts Violations database**

A facility claims portfolio is built from all UST info at a site **on or before** report_date in the claims data.

Comparing Risk Detection Methods

UST Data is rich in facility descriptions ~380 variables that describe a facility at report date.

I approached this analysis using two sets of information:

Approach 1: Standard Indicators. Based on established institutional knowledge (e.g., bare steel, tank age).

•**Approach 2: Machine Learning (ML) Data-Driven Discovery.** Using algorithms to identify non-obvious patterns across all ~380 facility variables.

* ML only feasible on full claims data

Drivers of Claim Denial

What Predicts Claim Denial?[1]

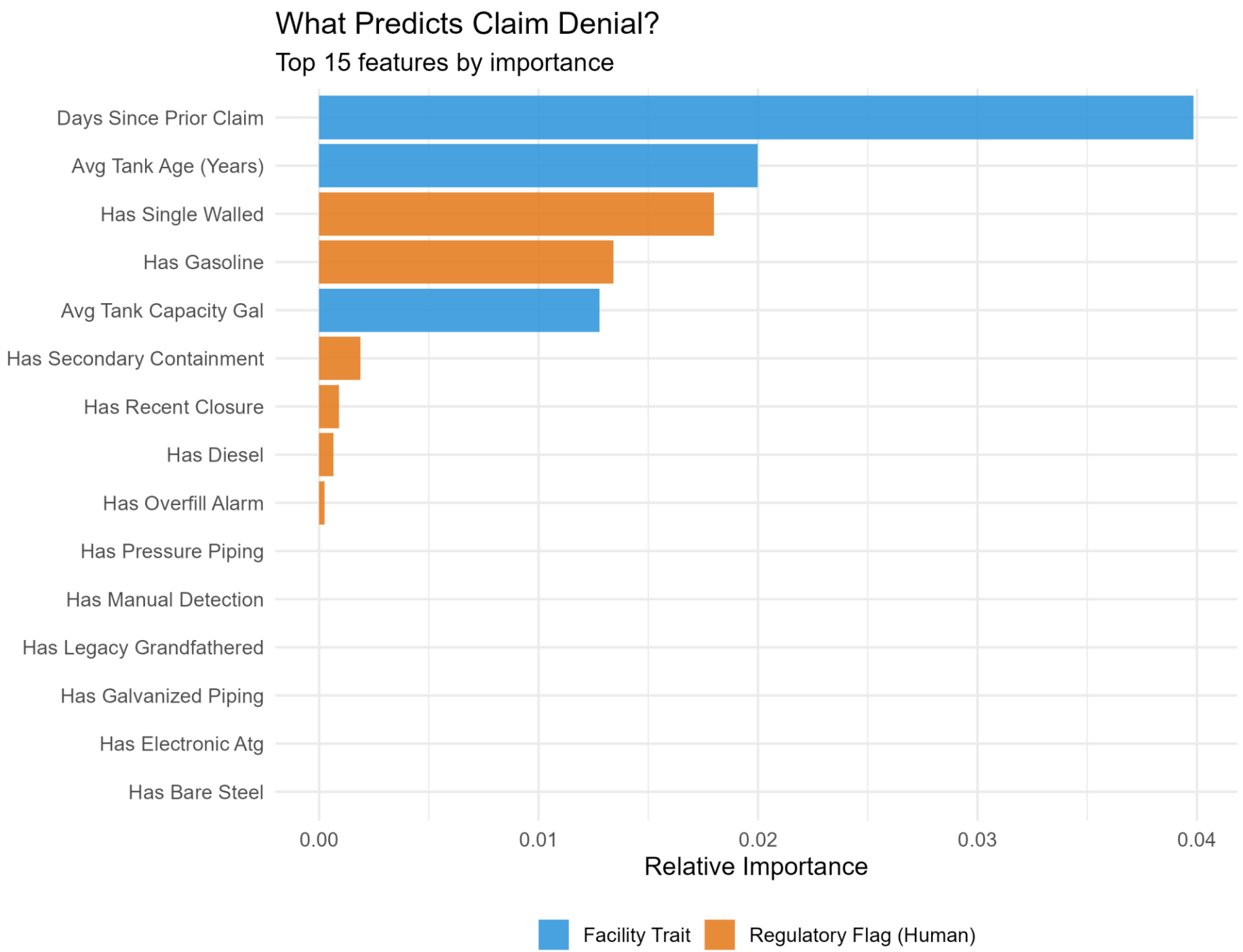
Linear Probability Model (Significant Marginal Effects)[1]

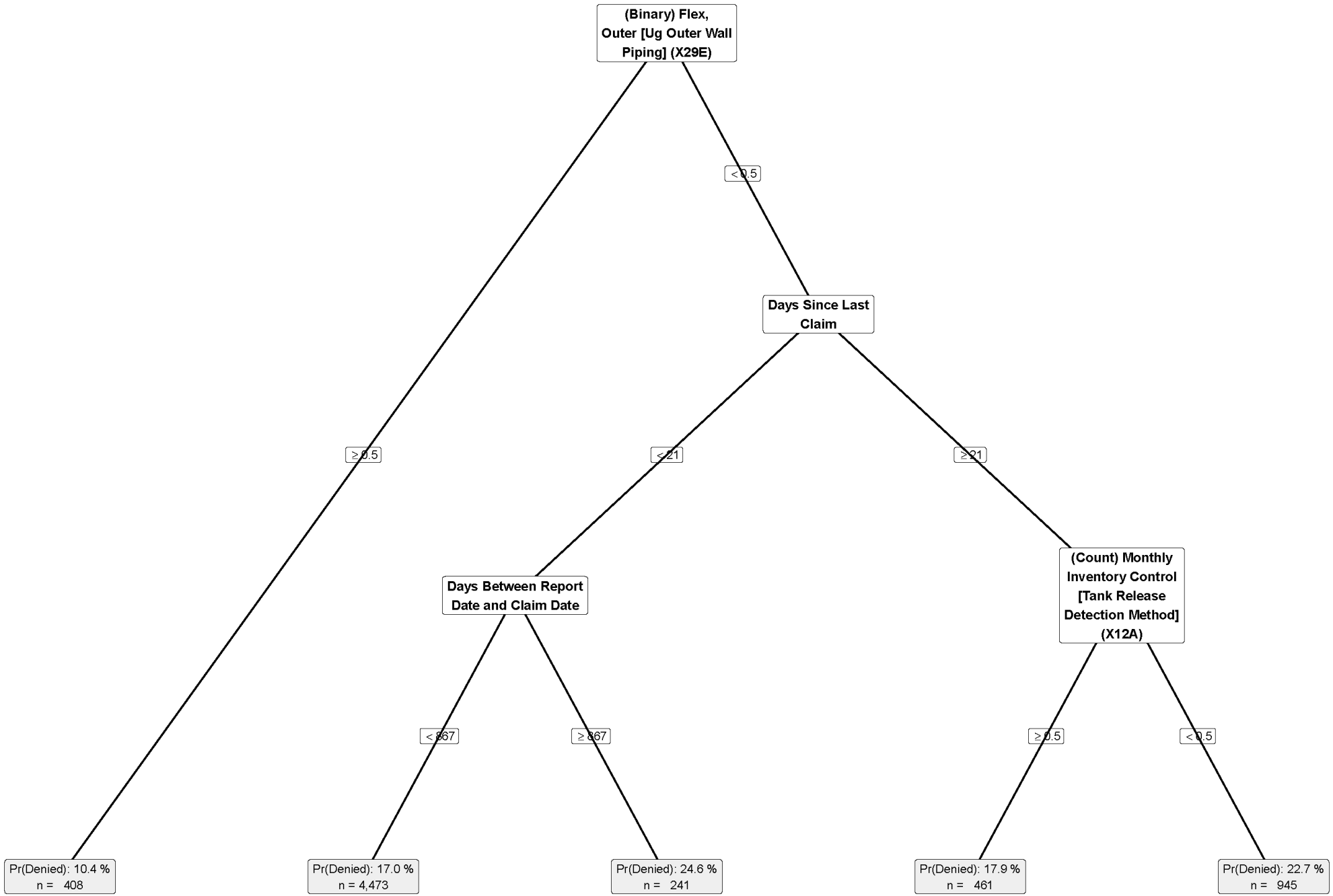
Predictor	Effect on Denial Risk[2]	Std. Error	P-Value
is_repeat_filerTRUE	12.84% (Increase)***	(2.43%)	0.0000
Has Single-Walled System	-6.13% (Decrease)***	(1.36%)	0.0000
Prior Claim Count	-3.02% (Decrease)***	(0.88%)	0.0006
Stores Gasoline	-2.73% (Decrease)*	(1.60%)	0.0877
Has Secondary Containment	-2.54% (Decrease)*	(1.53%)	0.0968
Stores Diesel	2.26% (Increase)**	(1.02%)	0.0259
Total Tanks at Facility	0.39% (Increase)**	(0.19%)	0.0347
Reporting Delay (Days)	0.01% (Increase)***	(0.00%)	0.0000
Days Since Last Claim	-0.00% (Decrease)*	(0.00%)	0.0810

[1] Controls: DEP Region and Year FE. Robust SEs.

[2] Values represent percentage point change in denial probability.

Showing 9 predictors with p < 0.10. * p<0.10, ** p<0.05, *** p<0.01

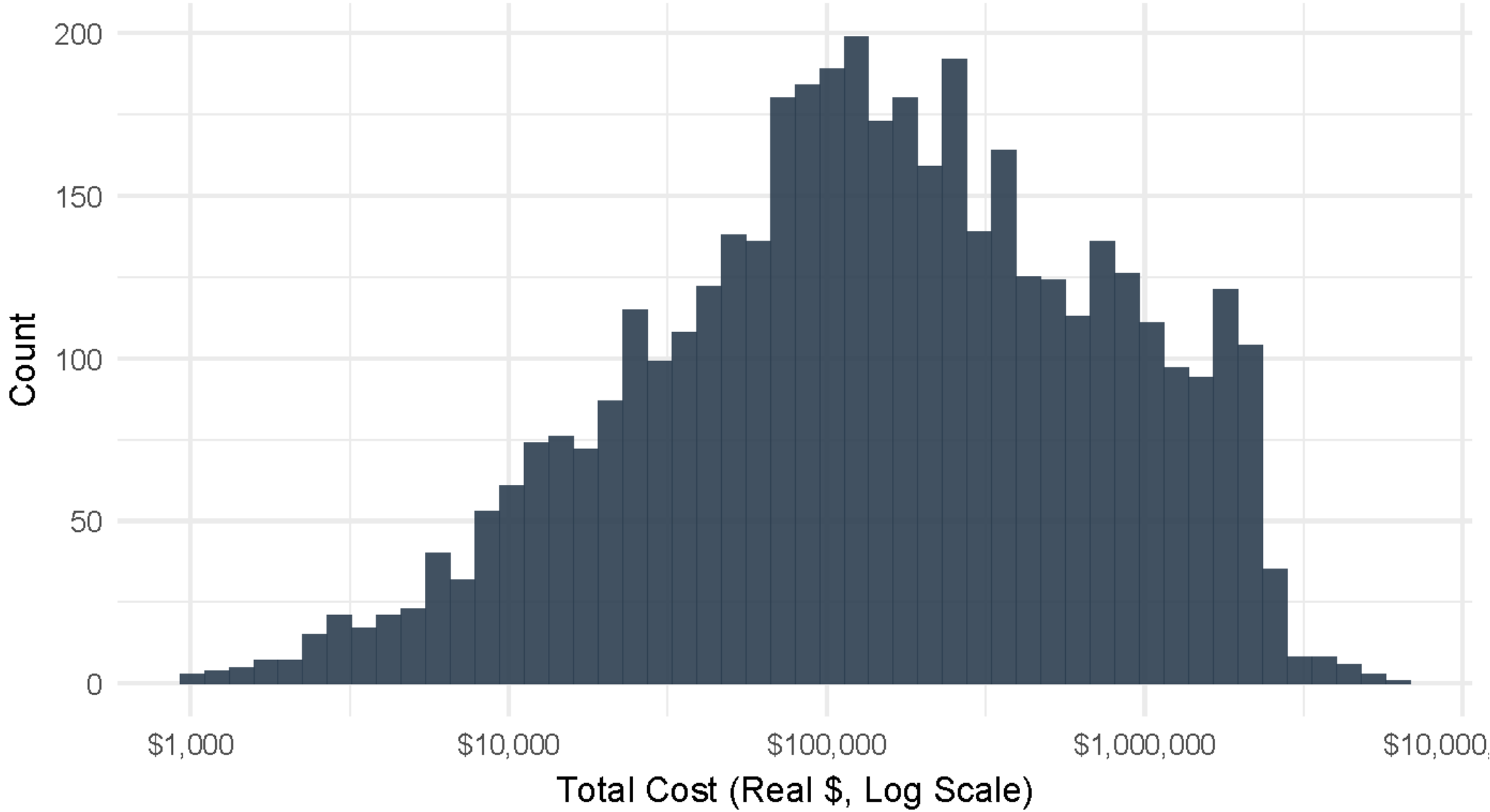

What Predicts Claim Denial?
Top 15 features by importance
Days Since Prior Claim
Avg Tank Age (Years)
Has Single Walled
Has Gasoline
Avg Tank Capacity Gal
Has Secondary Containment
Has Recent Closure
Has Diesel
Has Overfill Alarm
Has Pressure Piping
Has Manual Detection
Has Legacy Grandfathered
Has Galvanized Piping
Has Electronic Atg
Has Bare Steel
0.00
0.01
0.02
0.03
0.04
Relative Importance
Facility Trait
Regulatory Flag (Human)


Decision Rules for Pr(Denied)
(Binary) Flex, Outer [Ug Outer Wall Piping] (X29E)
< 0.5
≥ 0.5
Days Since Last Claim
< 21
≥ 21
Days Between Report Date and Claim Date
(Count) Monthly Inventory Control [Tank Release Detection Method] (X12A)
< 367
≥ 367
≥ 0.5
< 0.5
Pr(Denied): 10.4 %
n = 408
Pr(Denied): 17.0 %
n = 4,473
Pr(Denied): 24.6 %
n = 241
Pr(Denied): 17.9 %
n = 461
Pr(Denied): 22.7 %
n = 945

Drivers of Claim Cost

Total Claim Cost Distribution

N = 4,307 closed eligible claims



OLS: What Predicts Claim Cost?

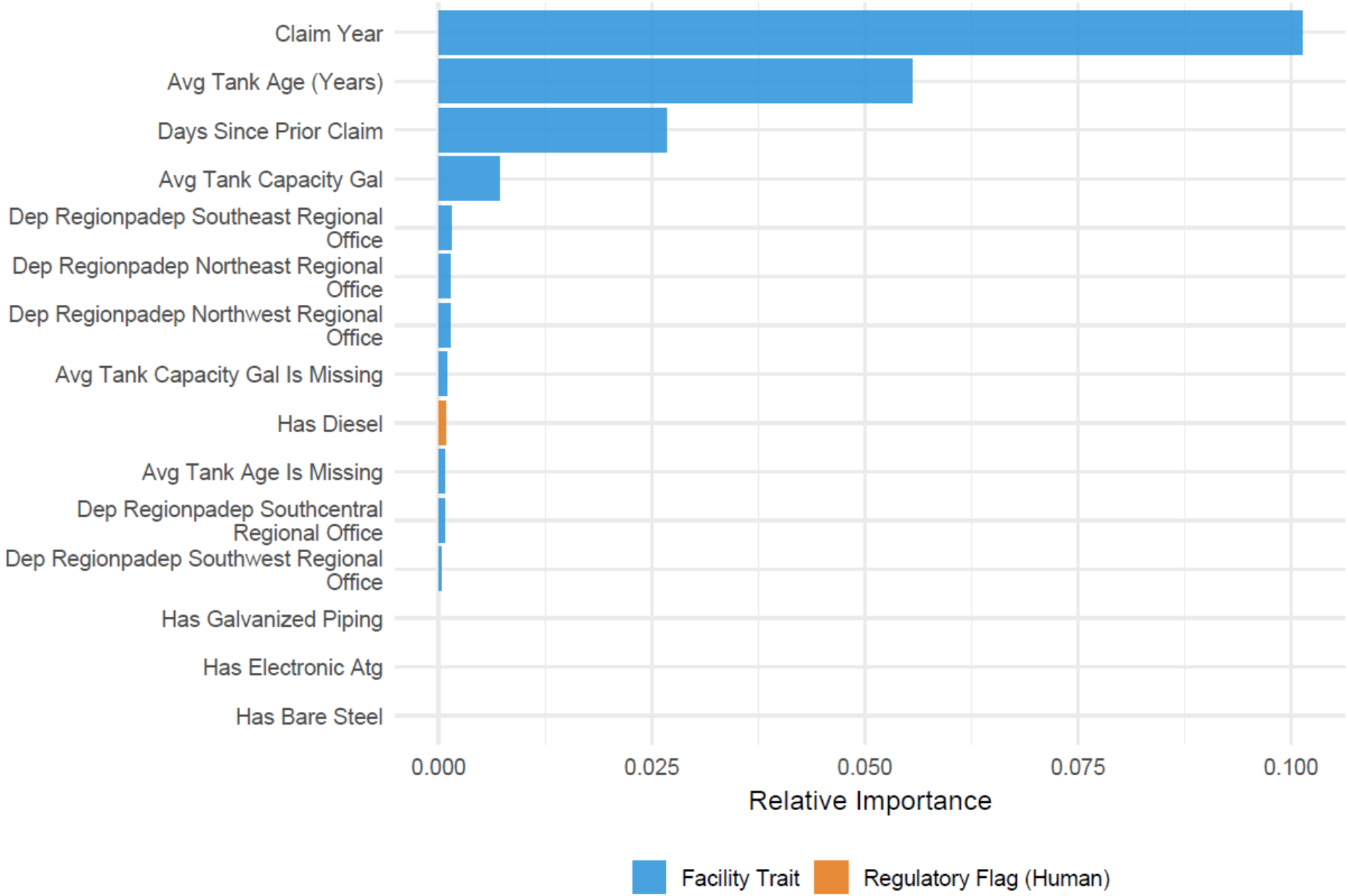
Dependent Variable: Log(Total Paid Real $)

Predictor	Effect (Log Scale)	Std. Error	P-Value
Stores Gasoline	58.97% (Increase)***	(9.95%)	0.0000
Avg Tank Age is Missing	40.91% (Increase)***	(13.49%)	0.0024
Has Single-Walled System	22.28% (Increase)***	(7.48%)	0.0029
has_recent_closureTRUE	-19.72% (Decrease)***	(5.36%)	0.0002
Prior Claim Count	-18.53% (Decrease)***	(5.64%)	0.0010
Total Tanks at Facility	5.26% (Increase)***	(0.99%)	0.0000
Avg Tank Age (Years)	0.80% (Increase)**	(0.38%)	0.0343
Reporting Delay (Days)	-0.04% (Decrease)***	(0.01%)	0.0000

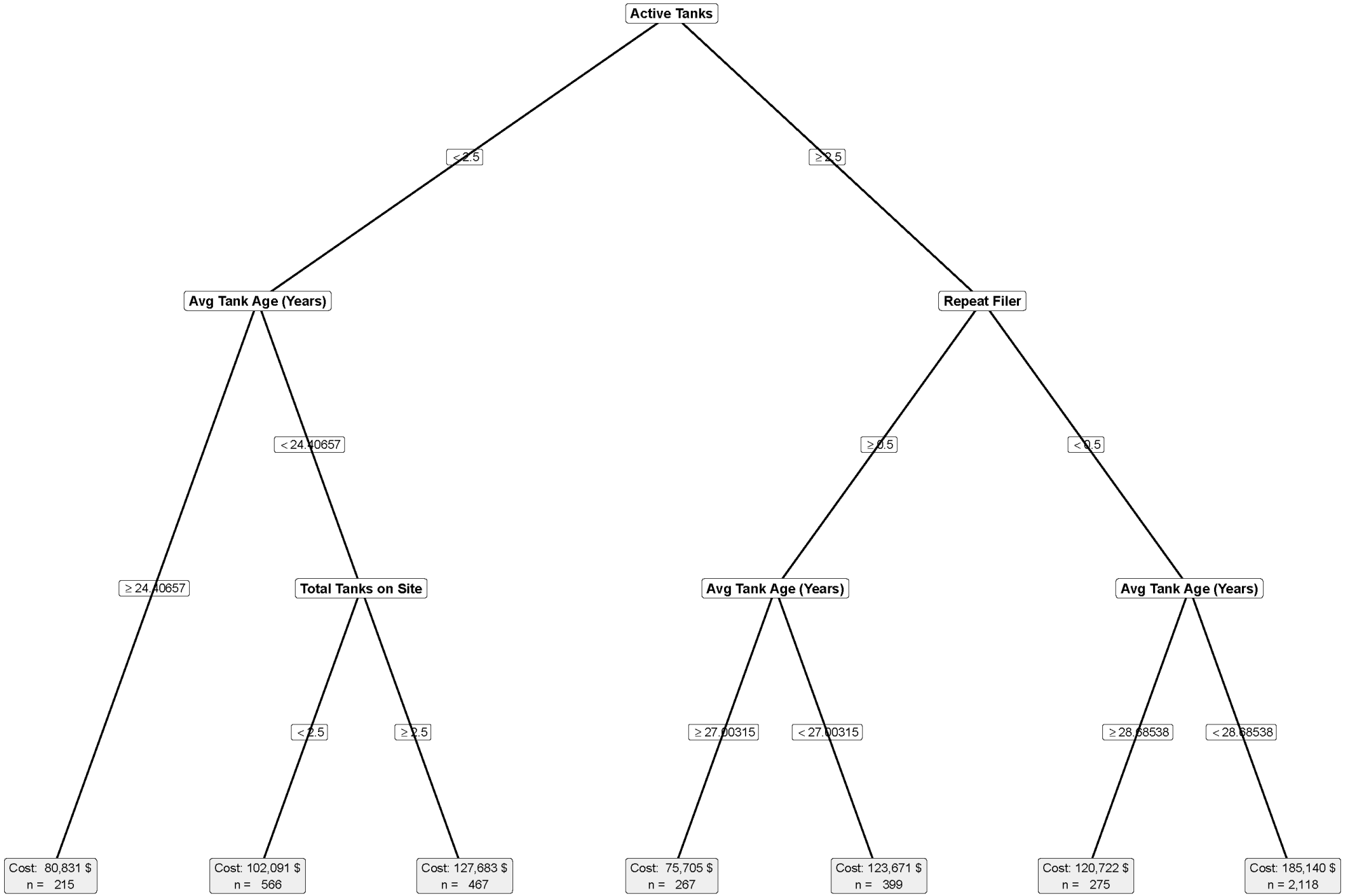
Controls: DEP Region & Year FE. Robust SEs. Showing p < 0.10 only.

What Predicts Claim Cost?

Top 15 features by predictive importance



Decision Rules for Cost



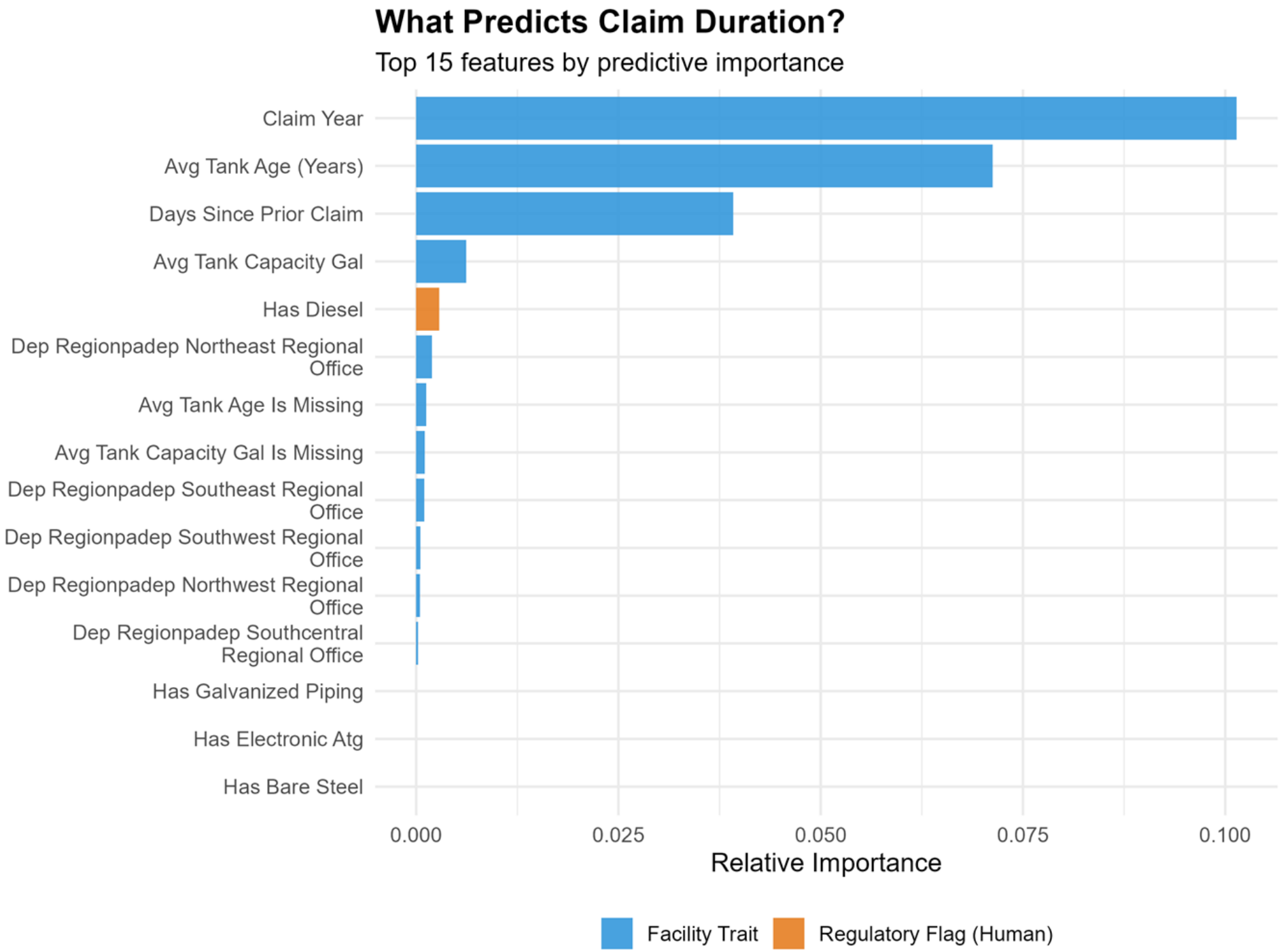
Drivers of Claim Duration

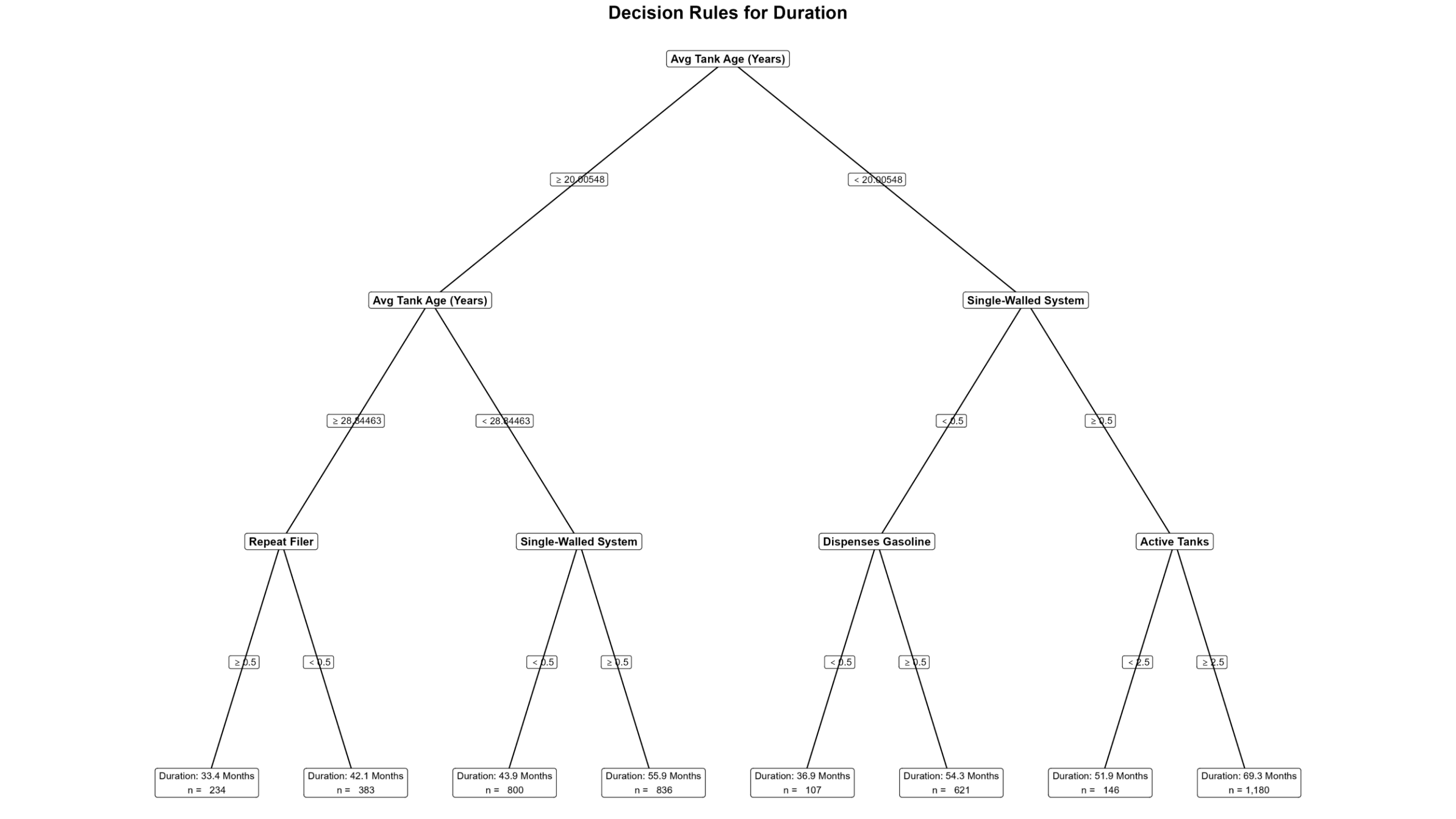
OLS: What Predicts Claim Duration?

Dependent Variable: Log(Duration in Months)

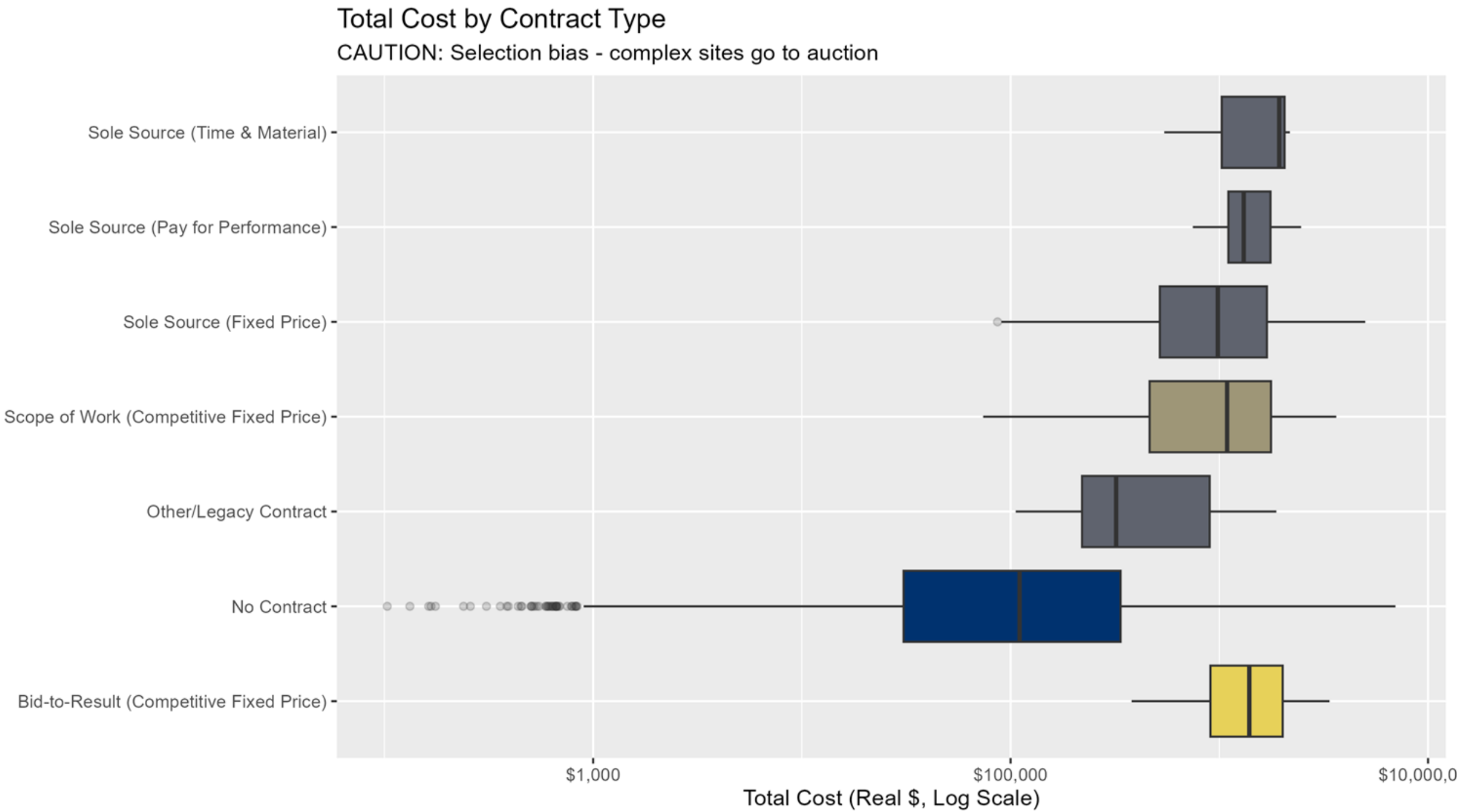
Predictor	Effect (Log Scale)	Std. Error	P-Value
Stores Gasoline	57.15% (Increase)***	(6.89%)	0.0000
Avg Tank Age is Missing	30.80% (Increase)***	(9.72%)	0.0015
has_recent_closureTRUE	-24.11% (Decrease)***	(3.63%)	0.0000
is_repeat_filerTRUE	-18.29% (Decrease)**	(7.62%)	0.0164
Has Single-Walled System	16.20% (Increase)***	(5.15%)	0.0017
Total Tanks at Facility	2.09% (Increase)***	(0.66%)	0.0016
Days Since Last Claim	0.00% (Increase)***	(0.00%)	0.0040

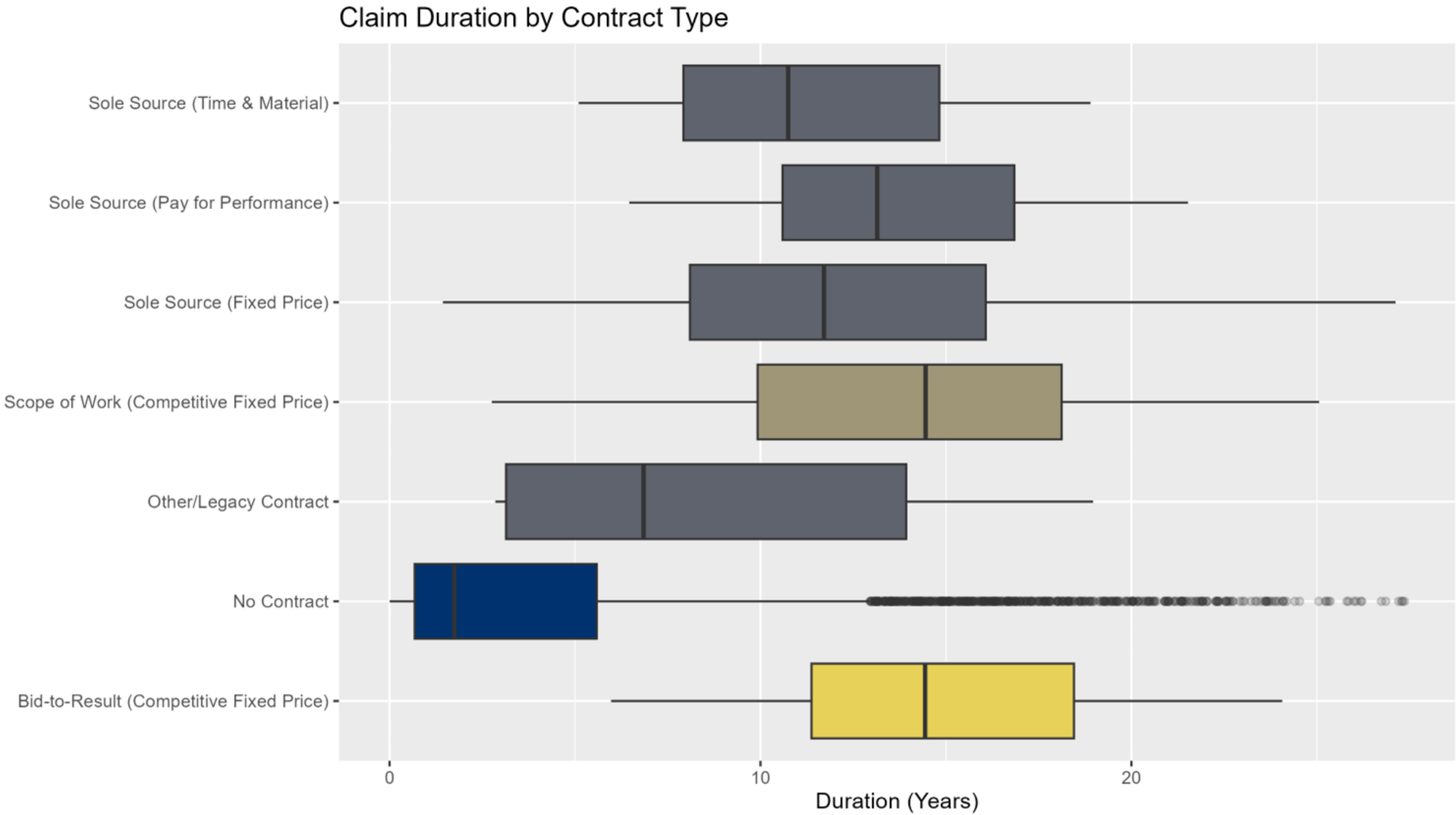
Controls: DEP Region & Year FE. Robust SEs. Showing p < 0.10 only.

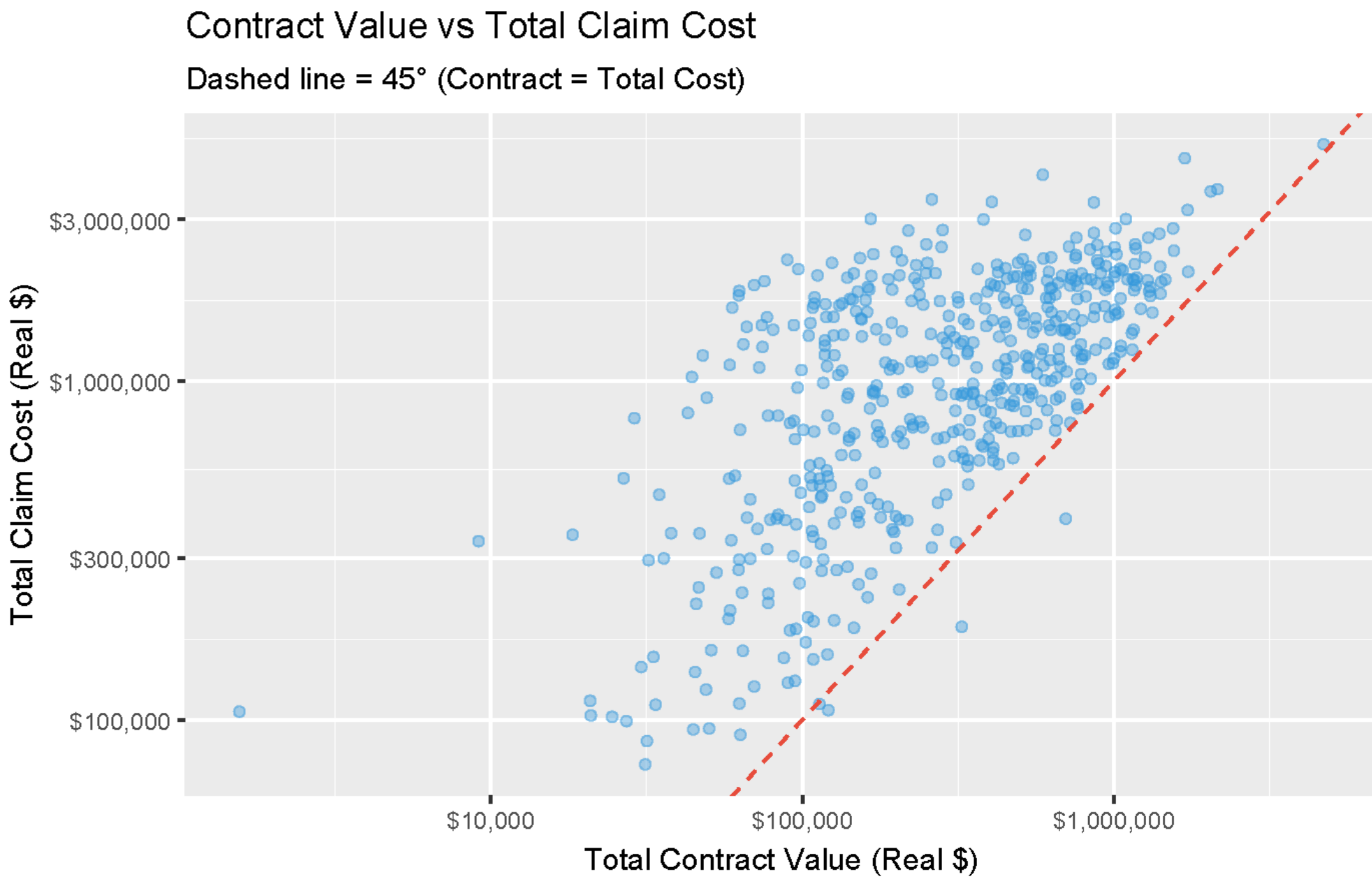

What Predicts Claim Duration?
Top 15 features by predictive importance
Claim Year
Avg Tank Age (Years)
Days Since Prior Claim
Avg Tank Capacity Gal
Has Diesel
Dep Regionpadep Northeast Regional Office
Avg Tank Age Is Missing
Avg Tank Capacity Gal Is Missing
Dep Regionpadep Southeast Regional Office
Dep Regionpadep Southwest Regional Office
Dep Regionpadep Northwest Regional Office
Dep Regionpadep Southcentral Regional Office
Has Galvanized Piping
Has Electronic Atg
Has Bare Steel
0.000
0.025
0.050
0.075
0.100
Relative Importance
Facility Trait
Regulatory Flag (Human)


Decision Rules for Duration
Avg Tank Age (Years)
≥ 20.00548
< 20.00548
Avg Tank Age (Years)
Single-Walled System
≥ 28.84463
< 28.84463
< 0.5
≥ 0.5
Repeat Filer
Single-Walled System
Dispenses Gasoline
Active Tanks
≥ 0.5
< 0.5
< 0.5
≥ 0.5
< 0.5
≥ 0.5
< 2.5
≥ 2.5
Duration: 33.4 Months
n = 234
Duration: 42.1 Months
n = 383
Duration: 43.9 Months
n = 800
Duration: 55.9 Months
n = 836
Duration: 36.9 Months
n = 107
Duration: 54.3 Months
n = 621
Duration: 51.9 Months
n = 146
Duration: 69.3 Months
n = 1,180

Contracts and Competitive Bidding


Total Cost by Contract Type
CAUTION: Selection bias - complex sites go to auction
Sole Source (Time & Material)
Sole Source (Pay for Performance)
Sole Source (Fixed Price)
Scope of Work (Competitive Fixed Price)
Other/Legacy Contract
No Contract
Bid-to-Result (Competitive Fixed Price)
$1,000
$100,000
$10,000,0
Total Cost (Real $, Log Scale)


Claim Duration by Contract Type
Sole Source (Time & Material)
Sole Source (Pay for Performance)
Sole Source (Fixed Price)
Scope of Work (Competitive Fixed Price)
Other/Legacy Contract
No Contract
Bid-to-Result (Competitive Fixed Price)
0
10
20
Duration (Years)


Contract Value vs Total Claim Cost
Dashed line = 45° (Contract = Total Cost)
Total Claim Cost (Real $)
$3,000,000
$1,000,000
$300,000
$100,000
$10,000
$100,000
$1,000,000
Total Contract Value (Real $)

What Predicts Competitive Auctions?[1]

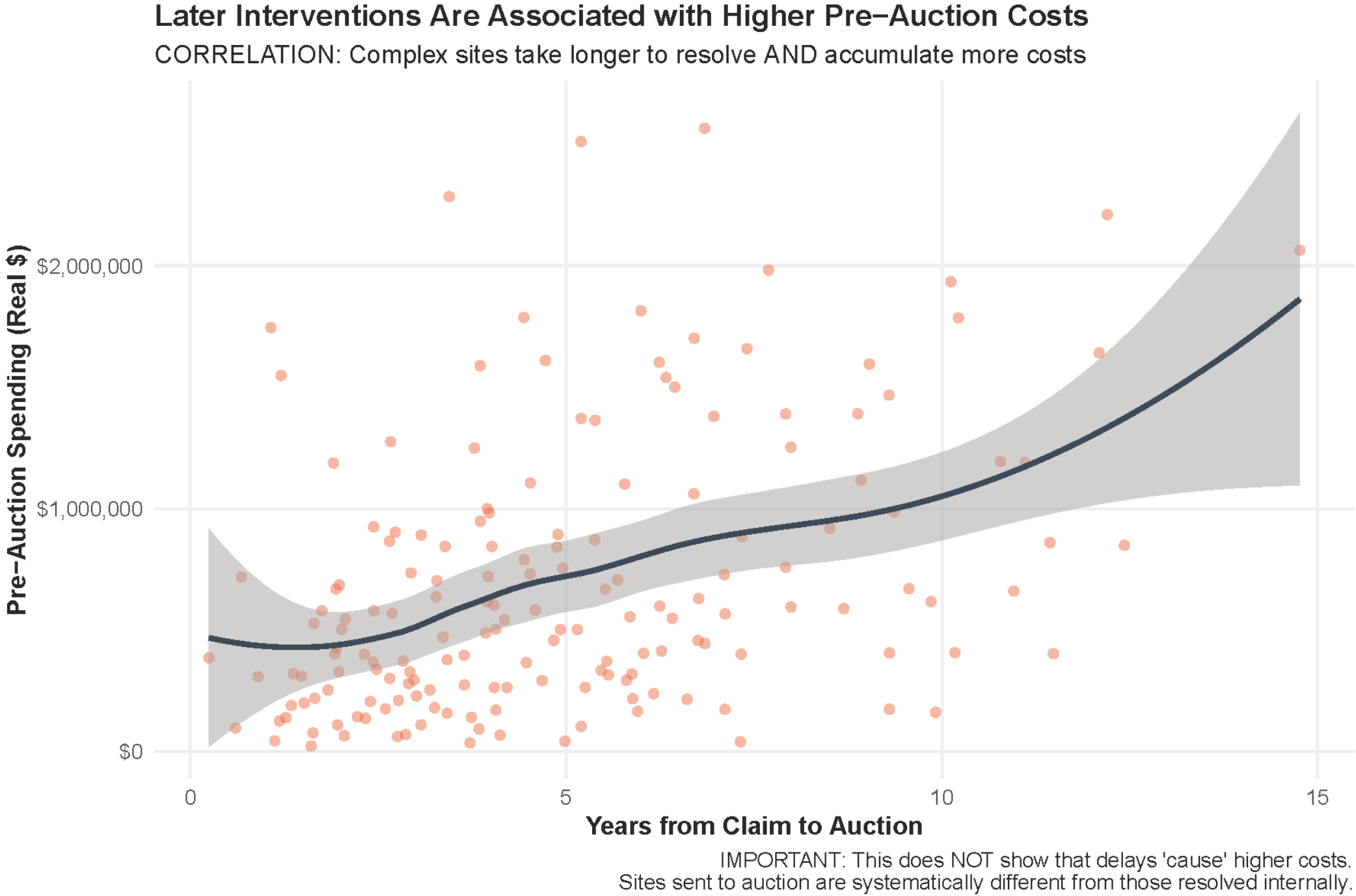
Linear Probability Model (Significant Marginal Effects)[1]

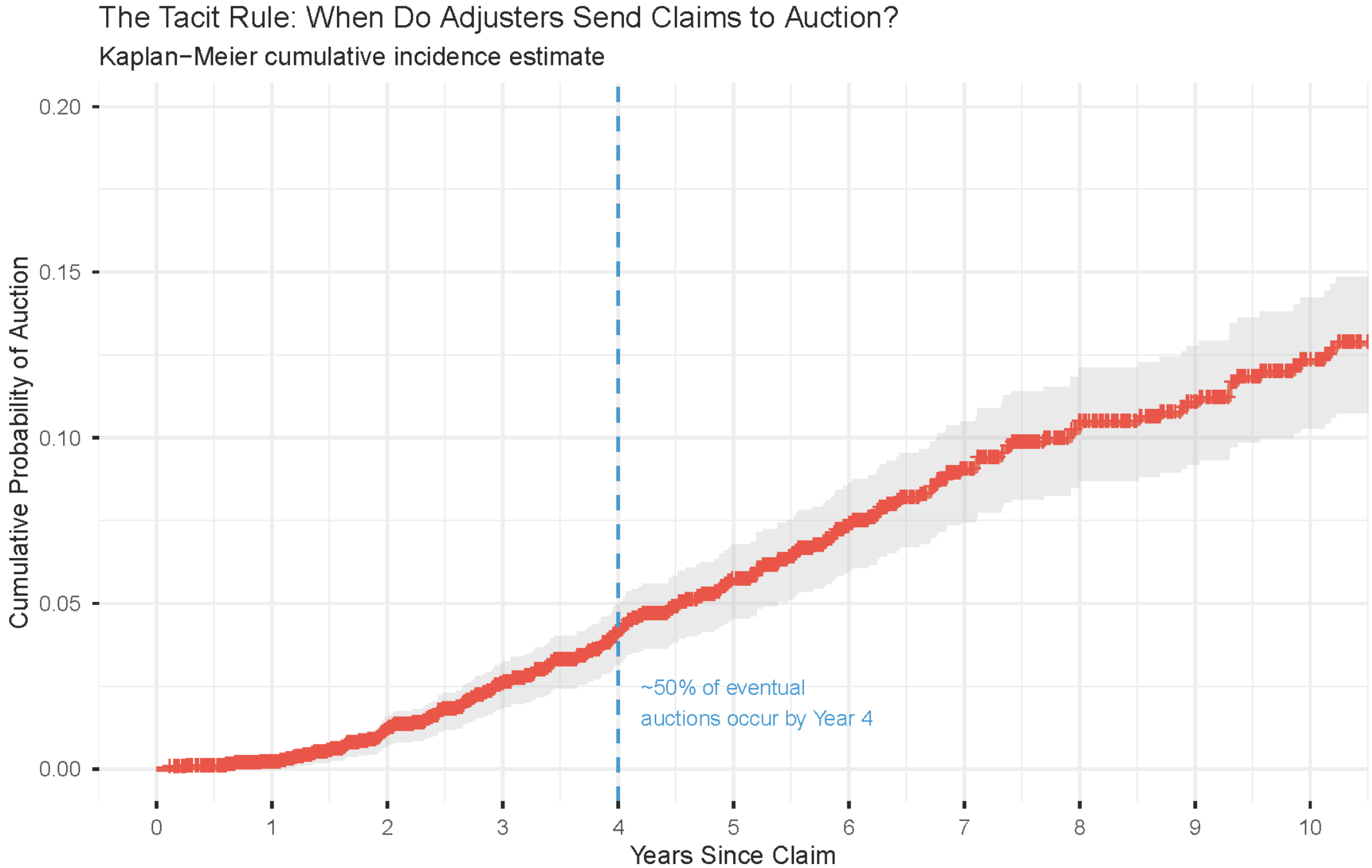
Predictor	Effect on Auction Probability[2]	Std. Error	P-Value
Has Tank Construction Unknown	-6.46% (Decrease)**	(1.61%)	0.0101
is_repeat_filerTRUE	-2.85% (Decrease)**	(0.93%)	0.0275
Total Tanks at Facility	0.15% (Increase)*	(0.06%)	0.0587
Avg Tank Capacity (Gal)	-0.00% (Decrease)*	(0.00%)	0.0690

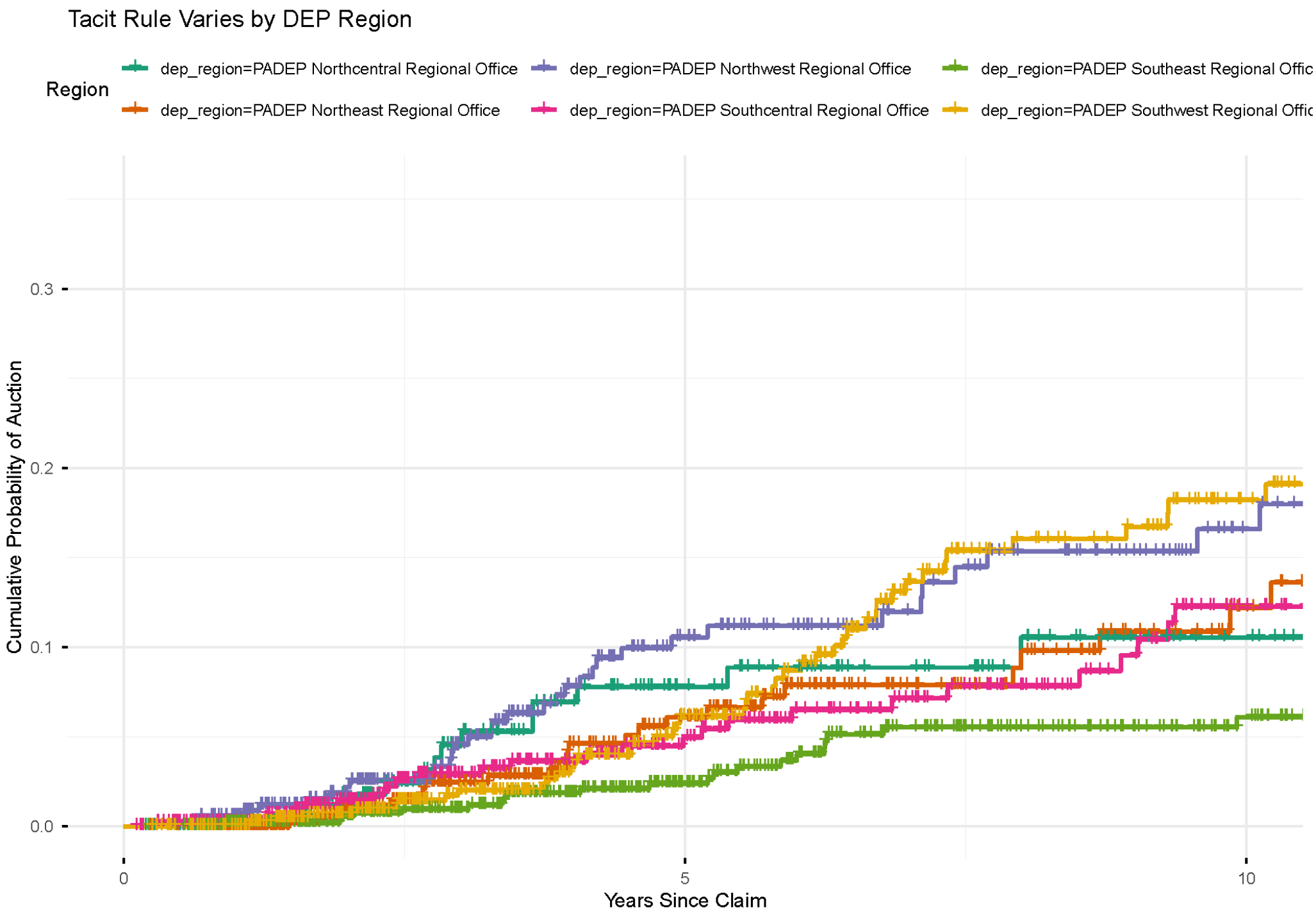
[1] Controls: DEP Region and Year FE. Clustered SEs (DEP Region).

[2] Values represent percentage point change in auction probability.

Showing 4 predictors with p < 0.10. * p<0.10, ** p<0.05, *** p<0.01


Later Interventions Are Associated with Higher Pre−Auction Costs
CORRELATION: Complex sites take longer to resolve AND accumulate more costs
Pre−Auction Spending (Real $)
$2,000,000
$1,000,000
$0
0
5
10
15
Years from Claim to Auction
IMPORTANT: This does NOT show that delays 'cause' higher costs.
Sites sent to auction are systematically different from those resolved internally.

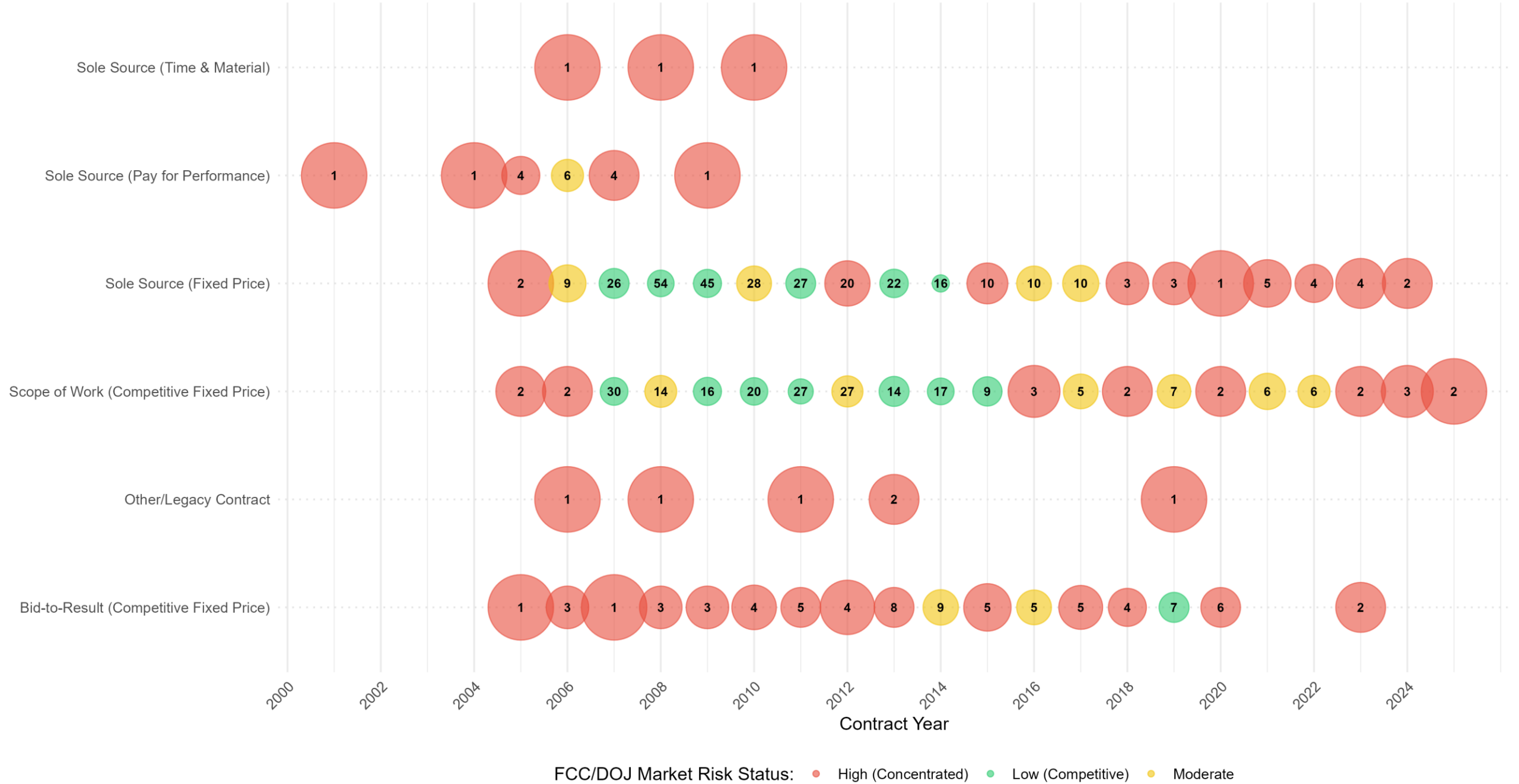

The Tacit Rule: When Do Adjusters Send Claims to Auction?
Kaplan−Meier cumulative incidence estimate
Cumulative Probability of Auction
0.20
0.15
0.10
0.05
0.00
~50% of eventual
auctions occur by Year 4
0
1
2
3
4
5
6
7
8
9
10
Years Since Claim
LIMITATION: This describes CURRENT practice, not optimal policy.


Tacit Rule Varies by DEP Region
Region
dep_region=PADEP Northcentral Regional Office
dep_region=PADEP Northeast Regional Office
dep_region=PADEP Northwest Regional Office
dep_region=PADEP Southcentral Regional Office
dep_region=PADEP Southeast Regional Offic
dep_region=PADEP Southwest Regional Offic
Cumulative Probability of Auction
0.3
0.2
0.1
0.0
0
5
10
Years Since Claim

Auction Market Concentration

Market Concentration Map (HHI Bubble by Win Count)

Numbers inside bubbles indicate total contract count for that year/type.



Market Competition Summary: Annual Averages (1994-2024)

Metrics based on Contract Counts (Win Frequency) rather than Revenue

Contract Type	HHI Score	Active Firms	Yearly Contracts	Avg Contract Cost	Avg Duration (Years)	Top Firm Win Share
Sole Source (Fixed Price)	3315 (2613)	7.5 (5.8)	15.1 (14.9)	$360,730 ($187,471)	8.2 (5.0)	42.3% (23.5%)
Bid-to-Result (Competitive Fixed Price)	4083 (2506)	3.4 (1.6)	4.4 (2.2)	$413,581 ($154,047)	8.7 (6.8)	45.8% (25.0%)
Scope of Work (Competitive Fixed Price)	2782 (1818)	6.5 (4.1)	10.7 (9.4)	$241,627 ($134,815)	8.0 (5.6)	33.9% (16.8%)
Sole Source (Pay for Performance)	6528 (3959)	2.5 (2.1)	2.8 (2.1)	$776,484 ($172,367)	13.8 (3.7)	65.3% (39.6%)
Sole Source (Time & Material)	10000 (0)	1.0 (0.0)	1.0 (0.0)	$611,725 ($688,999)	11.6 (6.9)	100.0% (0.0%)
Other/Legacy Contract	9000 (2236)	1.2 (0.4)	1.2 (0.4)	$416,572 ($366,685)	9.5 (7.9)	90.0% (22.4%)

Guide to Metrics:

- **Format:** Values are shown as *Average (Fluctuation/SD)*. Large numbers in parentheses indicate high year-to-year instability.
- **HHI Score:** Market Concentration (0 to 10,000). Higher scores = Less Competition.
- **Active Firms:** The average number of unique vendors winning at least one contract in a typical year.
- **Yearly Contracts:** Average annual volume. ***Note:*** *In years with very low volume (e.g., 1-3 contracts), HHI scores will mechanically show 'High Concentration' regardless of actual market health.*
- **Top Firm Win Share:** The percentage of contracts won by the single leading vendor in a typical year.

Risk Thresholds: Green < 1500 (Competitive); Yellow 1500-2500 (Moderate); Red > 2500 (Highly Concentrated).

Firm Entrenchment & Market Context

Contextualizing 'Winners' by Market Size and Cost Behavior (1994-2024)

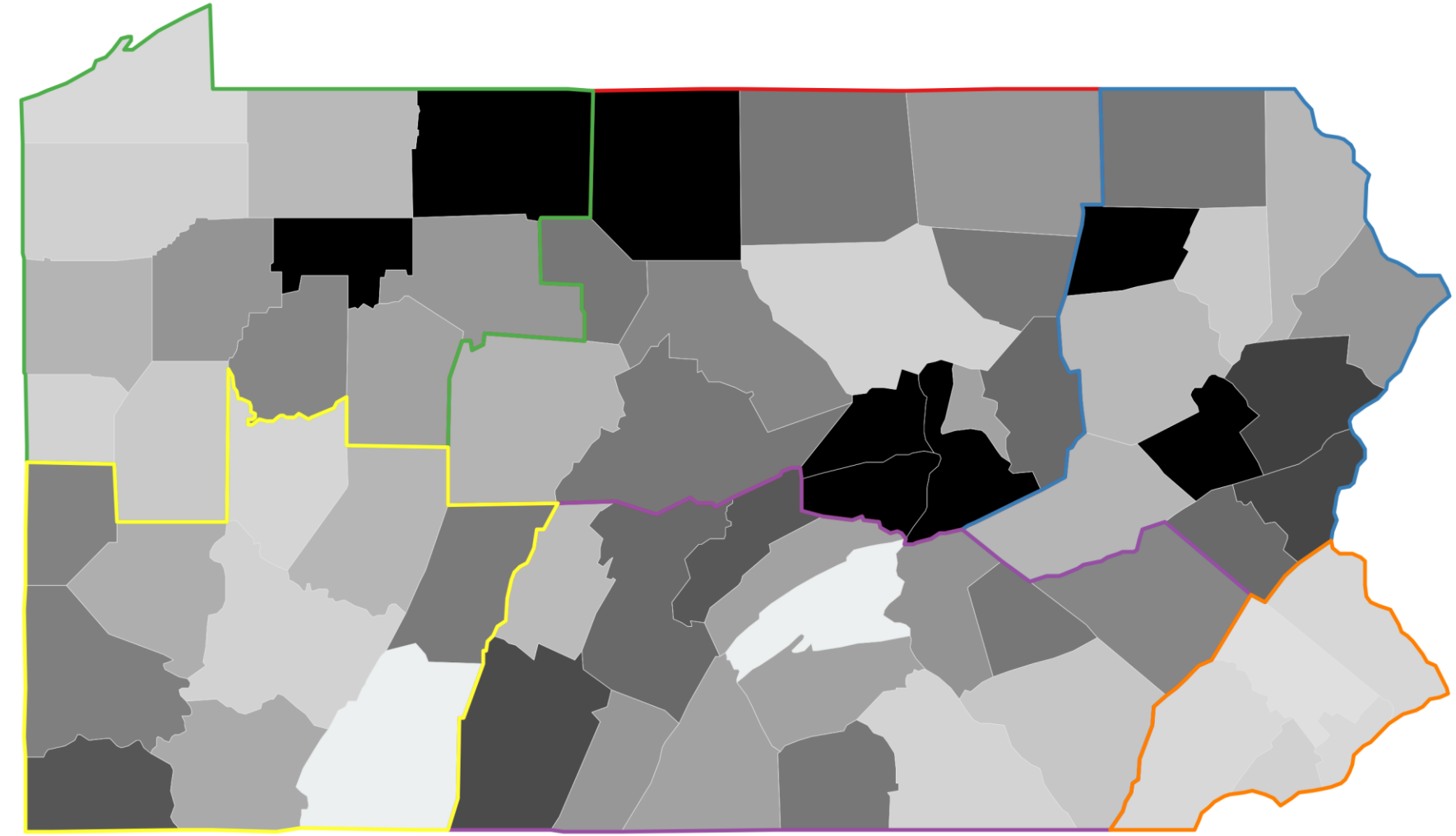
Contract Type	Market Leader	Total Contracts (N)	Entrenchment Rate	Market Breadth	Win Share	Relative Cost
Bid-to-Result (Competitive Fixed Price)	letterle & associates	75	17.6%	41.2%	20.0%	1.39
Other/Legacy Contract	mea	6	20.0%	40.0%	33.3%	0.91
Scope of Work (Competitive Fixed Price)	groundwater & environmental services	216	4.8%	47.6%	13.0%	0.66
Sole Source (Fixed Price)	letterle & associates	301	45.0%	75.0%	26.9%	1.11
Sole Source (Pay for Performance)	letterle & associates	17	0.0%	50.0%	23.5%	0.99
Sole Source (Time & Material)	austin james associates	3	33.3%	33.3%	33.3%	2.28

Column Definitions:

- **Market Leader:** The firm with the highest total number of contract awards (wins) within the category.
- **Total Contracts (N):** The absolute count of awards in that category; provides the scale for the HHI bubbles.
- **Entrenchment Rate:** The percentage of years where the Market Leader held the #1 spot for annual win count.
- **Market Breadth:** The percentage of years the firm was active (won at least one contract) out of all years the category existed.
- **Win Share:** The firm's lifetime percentage of total contracts awarded in that category.
- **Relative Cost:** (Winner's Avg Cost / Market Avg Cost). Values > 1.00 indicate the leader wins more expensive/complex sites than average.

Consultant Market Concentration (HHI by Win Count)

Darker counties indicate fewer firms winning the majority of contracts



HHI (Win Count)

0 2500 5000 7500 10000

DEP Region

Northcentral
Northwest
Southeast
Northeast
Southcentral
Southwest

HHI calculated using number of won contracts (Share of Access)

Possible Extensions

Risk Scoring and Improved Interventions Rules

Finding an Improved recommendation rule

What we know right now:

1. Current analysis suggest adjusters' push claims to auctions at 4-years.
2. Cost intervention is not clear at this point of the analysis

Can we do better?

If we know the value/return to competitive bidding:

1. Cost savings: Does the bidding process save PA money?
2. Time Savings: Does the bidding process expedited remediation process?
3. *Quality Improvements: Tough to measure?* Does the auction induce higher quality work?

Then we can optimize the claim to bidding pipeline to potentially reduce costs and speed up remediation.

Current challenge: The data provided and the process as I understand it doesn't allow us to answer those question at this time.

Finding an Improved recommendation rule

How does this work?

1) With known **returns** + a **risk scoring algorithm**

   We can think about different ways to target claims and calculate the cost/time/quality changes.

Next slides show the workflow

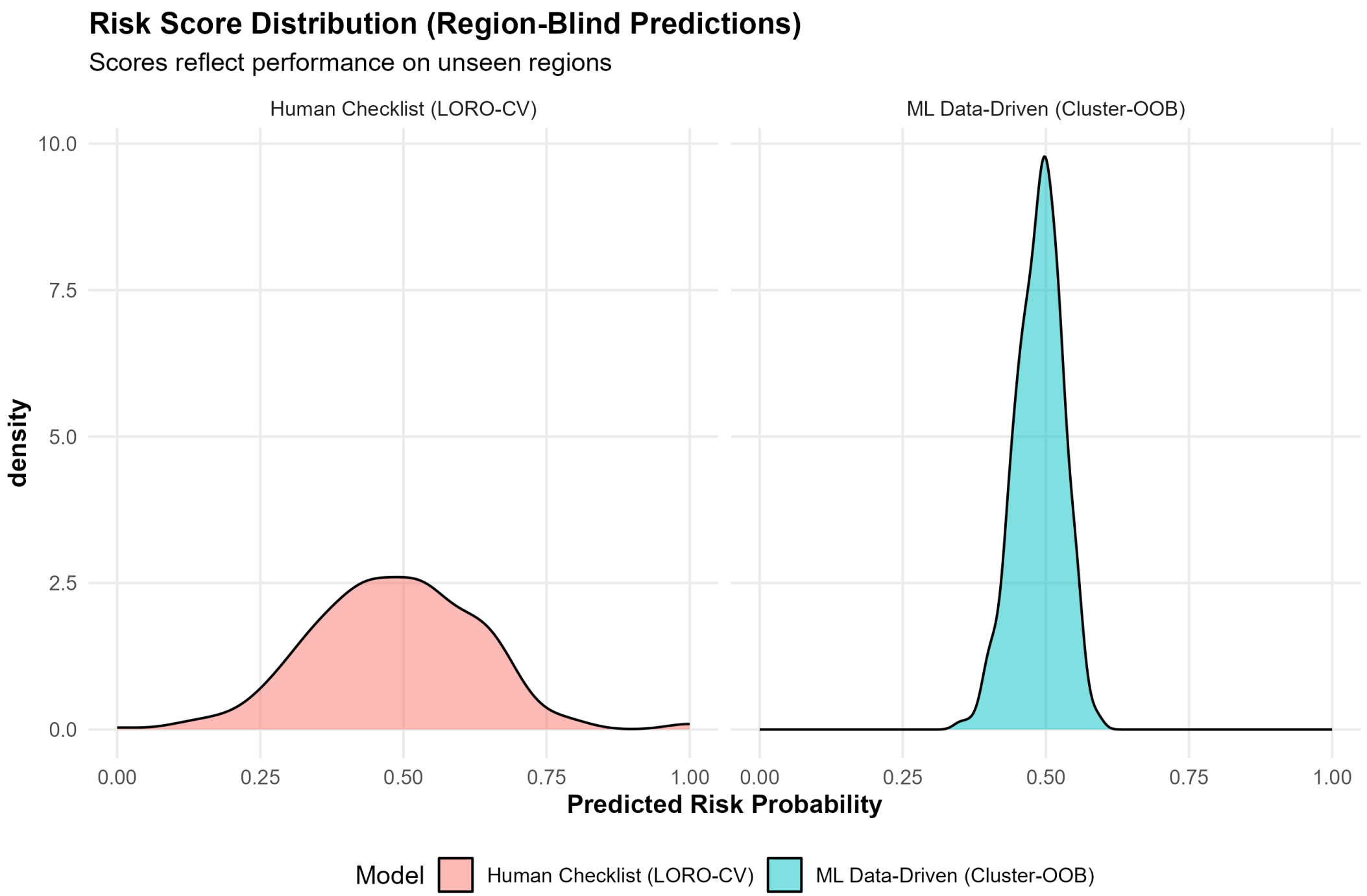

Risk Score Distribution (Region-Blind Predictions)
Scores reflect performance on unseen regions
Human Checklist (LORO-CV)
ML Data-Driven (Cluster-OOB)
density
10.0
7.5
5.0
2.5
0.0
0.00
0.25
0.50
0.75
1.00
Predicted Risk Probability
Model
Human Checklist (LORO-CV)
ML Data-Driven (Cluster-OOB)

Table 4.7: Early Warning System Feasibility & Value Analysis

Metric	Value
1. Model Performance	
How well does ML predict auctions?	Better than random guessing
ML Success Rate (Precision)	39.7% (vs 43.3% baseline)
Improvement over Random (Lift)	0.92x better
2. Severity Thresholds	
What defines a 'Severe' claim?	Top 10% most expensive or longest duration
Cost / Time Levels	Cost > $1,118,624 or Duration > 13.8 years
3. Value Simulation	
If we flagged the top 20% early...	We catch 25 actual auction cases
Recoverable 'Sunk Cost' (Upper Bound)*	**$21,589,983 (avg $863,599 per case)**

Definitions:

* Sunk Cost: Money spent on cleanup before the auction decision was made.

** Precision: % of flagged claims that actually went to auction.

*** Lift: How many times better the model is compared to random selection.

Whats needed to go further?

Two data questions and one bigger design questions

1) Is it possible to get claims adjusters assigned for all claims not just those in the contracts?

2) Is it feasible to get the claims cost flows? For example:

we see like the year-month spend for claim id [abc123]?

3) Improved Auction data? – currently we only know the winners to really study the returns to auctions we need more info of what happens during each auction: full bid lists, SOW milestones? etc

3) Feasibility of data-driven claim to auction policy experiment?