

Online Appendix to “The Cost of Risk Management”

1 Simple Model of Paver Problem

Consider the following simple model describing a paving firm’s profit maximization problem when bidding in a highway procurement auction. The firm submits unit price bids for bitumen, b_B , and for everything else, b_O . He knows the actual quantities that he will use, q_B^a and q_O^a , but his total bid B is calculated based on the DOT estimated quantities, q_B^e and q_O^e .¹ Conditional on his optimal total bid B , which determines his chances of winning the project (he wins if he submits the lowest total bid), the paver solves:

$$\begin{aligned} \max_{b_B, b_O} \pi &= b_B q_B^a + b_O q_O^a - \frac{1}{2} \eta \left[(b_B - \tilde{c}_B)^2 - (b_O - c_O)^2 \right] \\ \text{s.t. } &b_B q_B^e + b_O q_O^e \leq B \end{aligned} \quad (1)$$

The firm’s cost for of bitumen is $\tilde{c}_B = c_B + \rho$, where ρ is a non-negative risk premium, or the value of hedging to the firm. I do not microfound this parameter; it may be due to financial constraints, agency problems, or owner preferences. The last term in Equation 2 reflects a penalty for excessive skewing. To the extent that $q^e \neq q^a$ on any item, the bidder has an incentive to skew his bid toward the quantity that has been underestimated. He can then lower B , increasing his chance of winning, but in expectation get paid the same. Following Bajari et al. (2014), I use a quadratic penalty η for deviating from the engineering cost estimates.

The firm’s FOC is:

$$\frac{\partial}{\partial b_B} : q_B^a - \lambda q_B^e = \eta (b_B - \tilde{c}_B) \quad (2)$$

where λ is a Lagrange multiplier, which I assume may be a function of everything unrelated to oil price risk, such as the marginal benefit of bidding a bid that scores higher, how others are skewing, etc. Specifically, $\lambda = \frac{\eta}{(q_B^e)^2 + (q_O^e)^2} \left[q_B^e \tilde{c}_B + q_O^e c_O + \frac{1}{\eta} (q_B^a q_B^e + q_O^a q_O^e) - B \right]$. Solving

¹This simplifies the notion that the paving firm is more informed than the state about the quantities he will use.

for the bitumen bid b_B gives:

$$b_B = \tilde{c}_B + \frac{1}{\eta} (q_B^a - \lambda q_B^e) = c_B + \rho + \frac{1}{\eta} (q_B^a - \lambda q_B^e) \quad (3)$$

This unit item bid is the expected cost plus a markup that includes the paving firm's cost of risk. This markup is:

$$m_B = b_B - c_B = \rho + \frac{1}{\eta} (q_B^a - \lambda q_B^e). \quad (4)$$

Equation 5 leads to the reduced form estimation in Section 6.2.

2 Additional Tables and Figures

Table 1: Selection into Projects by Firm Type (Part 1)

Project characteristic	Mean	N	Mean	N	P-value of difference
<i>Panel 1: Public ownership</i>					
	Public firms		Private firms		
Bitumen quantity (tons)	940.0	4857	980.7	816	0.37
Distance firm to project (miles)	82.9	4857	93.9	816	0.02**
Number of bidders	4.7	4857	3.6	816	0.00***
Months to start	4.8	4233	4.6	627	0.13
<i>Panel 2: Family ownership</i>					
	Non family-owned firms		Family-owned firms		
Bitumen quantity (tons)	869.2	2140	992.4	3533	0.00***
Distance firm to project (miles)	89.8	2140	81.2	3533	0.01**
Number of bidders	4.2	2140	4.8	3533	0.00***
Months to start	4.8	1663	4.8	3197	0.89
<i>Panel 3: Diversification</i>					
	Diversified		Paving only		
Bitumen quantity (tons)	979.7	2708	965.1	2614	0.66
Distance firm to project (miles)	83.0	2708	83.8	2614	0.78
Number of bidders	4.1	2708	4.9	2614	0.00***
Months to start	4.7	2474	4.9	2267	0.02**

Note: This table summarizes means of project characteristics (used as control variables in the regressions) by firm type. The p-values give statistical significance on the difference between the two means.

Table 2: Selection into Projects by Firm Type (Part 2)

Project characteristic	Mean	N	Mean	N	P-value of difference
<i>Panel 4: Size (Measure 1)</i>					
	Multiple Location		Single Location		
Bitumen quantity (tons)	1132.10	3990	477.3	1474	0.00***
Distance firm to project (miles)	83.77	3990	81.3	1474	0.45
Number of bidders	4.42	3990	4.8	1474	0.00***
Months to start	4.80	3650	4.7	1108	0.45
<i>Panel 5: Size (Measure 2)</i>					
	Large firms		Small firms		
Bitumen quantity (tons)	1014.1	4085	791.03	1402	0.00***
Distance firm to project (miles)	85.4	4085	75.78	1402	0.00***
Number of bidders	4.6	4085	4.45	1402	0.10
Months to start	4.8	3619	4.80	1186	0.70
<i>Panel 6: Credit risk</i>					
	Low risk		High risk		
Bitumen quantity (tons)	982.3	4146	678.6	474	0.00***
Distance firm to project (miles)	82.4	4146	105.9	474	0.00***
Number of bidders	4.6	4146	3.9	474	0.00***
Months to start	4.8	3579	4.8	282	0.9

Note: This table summarizes means of project characteristics (used as control variables in the regressions) by firm type. The p-values give statistical significance on the difference between the two means.

Table 3: Oil Price Data Summary Statistics, 1998-2012

	Mean (sd)	N
Oil futures price (WTI, 6 mo. contract)	55 (29)	6,107
Hist vol (12 week, 6 mo. contract)	28 (9.2)	6,107
Hist vol (26 week, 6 mo. contract)	29 (9.5)	6,107
Implied vol (3 mo. expiration, 6 mo. contract)	34 (7.3)	6,107

Note: This table summarizes the oil price and volatility data used in the regression analysis.

Table 4: Robustness Tests of Policy Effect on Cost to Kansas

Dependent variable: \$/ton paid by DOT				
	Bitumen-intensive vs. non-bitumen-intensive paving contracts [‡]		Error Cluster Assumptions	
	(1)	(2)	None (robust)	Firm- state
			(3)	(4)
$\mathbf{I}_{Kansas_j} \cdot \mathbf{I}_{Post Policy_t}$			-43**	-43***
			(20)	(13)
$\mathbf{I}_{Bitumen Intensive_j} \cdot \mathbf{I}_{Post Policy_t}$	-54***	-49***		
	(8.5)	(8.9)		
\mathbf{I}_{Kansas_j}			273***	273***
			(12)	(7.2)
$\mathbf{I}_{Post Policy_t}$	324***	317***	39***	39***
	(8.6)	(10)	(11)	(8.8)
$\mathbf{I}_{Bitumen Intensive_j}$	39***	34***		
	(3.2)	(2.9)		
Controls [†]	Y	Y	Y	Y
Month-of-year f.e.	Y	Y	Y	Y
County-year f.e.	Y	Y	Y	Y
Firm f.e.	N	Y	N	N
N	2887	2887	1637	1637
R^2	0.821	0.840	0.798	0.798

Note: This table reports estimates of Equation 1. Columns 1-2 report the effect of the policy on the actual price paid per ton of bitumen by Kansas, comparing contracts that are more bitumen-intensive to those that are less bitumen-intensive. All contracts use some bitumen. For example, a less-intensive contract may have some road paving but also some bridge building. The definition of more intensive is that defined for inclusion in the main analysis; the portion of the bid for bitumen must be at least \$50,000. [†]Unreported controls are log total non-bitumen bid, log bitumen tons proposed, log paver miles to project, average total bid in the auction, oil price, and the number of bidders. Standard errors clustered by firm. *** $p < .01$.

Table 5: Risk Shifting Policy Effect on Real Outcomes without Fixed Effects

Dependent variable:	Log bid	# bidders	Prob. of winning across firm types	
			Private vs. public	Paving-only vs. diversified
	(1)	(2)	(3)	(4)
$\mathbf{I}_{Kansas_j} \cdot \mathbf{I}_{Post\ Policy_t}$	-0.081*** (.028)	1.1*** (.23)	-.11 (.098)	-.12* (.063)
$\mathbf{I}_{Kansas_j} \cdot \mathbf{I}_{Post\ Policy_t} \cdot \mathbf{I}_{Privately-owned_i}$			.14 (.1)	
$\mathbf{I}_{Kansas_j} \cdot \mathbf{I}_{Post\ Policy_t} \cdot \mathbf{I}_{Paving\ Only_i}$				.2*** (.073)
\mathbf{I}_{Kansas_j}	.16*** (.021)	-.0025 (.25)	.19** (.091)	.18*** (.047)
$\mathbf{I}_{Post\ Policy_t}$	.84*** (.012)	-.95*** (.16)	-.099 (.09)	-.082*** (.021)
$\mathbf{I}_{Kansas_j} \cdot \mathbf{I}_{Privately-owned_i}$			-.096 (.084)	
$\mathbf{I}_{Post\ Policy_t} \cdot \mathbf{I}_{Privately-owned_i}$			.046 (.083)	
$\mathbf{I}_{Kansas_j} \cdot \mathbf{I}_{Paving\ Only_i}$				-.051 (.063)
$\mathbf{I}_{Post\ Policy_t} \cdot \mathbf{I}_{Paving\ Only_i}$				.013 (.025)
$\mathbf{I}_{Privately-owned_i}$			-.029 (.079)	
$\mathbf{I}_{Paving\ Only_i}$				-.081*** (.017)
Controls [†]	Y	Y	Y	Y
Month-of-year f.e.	N	N	N	N
County-year f.e.	N	N	N	N
N	6111	1794	6324	5921
R^2	0.797	0.179	0.171	0.177

Note: This table reports estimates of the effect of the risk shifting policy in Kansas vs. Iowa after vs. before the policy, using variations on Equation 1. Each observation is an auction in I and III, and a bid in II, IV, V. The dependent variable in IV and V is 1 if the firm won the auction, and each column interacts the policy effect with a firm type. N is lower in I because KDOT lost some payments data. [†]Unreported controls are log total non-bitumen bid, log bitumen tons proposed, log paver miles to project, average total bid in the auction, oil price. The number of bidders is also included in I and III. Standard errors clustered by firm. *** $p < .01$.

Table 6: Policy effect within Kansas across Contracts and Contract Items

Dependent variable:	Log item bid		Log bitumen bid	
	Bitumen vs. other items		Sample restricted to firms that bid:	
	in bid		in both states	in one state
	(1)	(2)	(3)	(4)
$\mathbf{I}_{Bitumen\ Item} \cdot \mathbf{I}_{Post\ Policy_t} \cdot Vol_t^{oil}$	-.44*** (.12)	-.45*** (.13)		
$\mathbf{I}_{Kansas_j} \cdot \mathbf{I}_{Post\ Policy_t} \cdot Vol_t^{oil}$			-.067 (.12)	-.19*** (.038)
$\mathbf{I}_{Post\ Policy_t} \cdot Vol_t^{oil}$	.25*** (.061)	.26*** (.061)	.77*** (.07)	.76*** (.047)
$\mathbf{I}_{Bitumen} \cdot Vol_t^{oil}$	.46*** (.12)	.46*** (.13)		
$\mathbf{I}_{Bitumen} \cdot \mathbf{I}_{Post\ Policy_t}$	.2*** (.4)	.2*** (.41)		
$\mathbf{I}_{Kansas_j} \cdot \mathbf{I}_{Post\ Policy_t}$			.27 (.38)	.57*** (.13)
$\mathbf{I}_{Kansas_j} \cdot Vol_t^{oil}$			-.071 (.086)	.062** (.031)
\mathbf{I}_{Kansas_j}			.36 (.28)	-.091 (.098)
Vol_t^{oil}	-.21*** (.059)	-.21*** (.061)	-.027* (.015)	.015 (.011)
$\mathbf{I}_{Bitumen}$	-.10*** (.39)	-.10*** (.4)		
$\mathbf{I}_{Post\ Policy_t}$	-.99*** (.21)	-.1*** (.21)	-2.3*** (.18)	-2.3*** (.15)
$\ln price_t^{oil}$	.069*** (.02)	.058*** (.019)	.19*** (.059)	.3*** (.036)
Controls [†]	Y	Y	Y	Y
Month-of-year f.e.	Y	Y	Y	Y
County-year f.e.	Y	Y	Y	Y
Firm f.e.	N	Y	N	N
N	12450	12450	915	5196
R^2	0.982	0.982	0.938	0.911

Note: Columns 1-2 report regression estimates of the effect of the risk removal policy on an additional unit of historical oil price volatility on bitumen items vs. non-bitumen items ($\mathbf{I}_{Bitumen}$) after vs. before the policy, using variations on Equation 3 with only Kansas data. Non-bitumen items are summed together, so that the total bid has two parts, $\mathbf{I}_{Bitumen}=1$ and $\mathbf{I}_{Bitumen}=0$. The dependent variable is the log bitumen item bid. Columns 3-4 show the main result in alternative samples. [†]Unreported controls are log total non-bitumen bid, log bitumen tons proposed, log paver miles to project, average total bid in the auction, and the number of bidders. Standard errors clustered by firm. *** $p < .01$.

Table 7: Further Robustness Tests of Main Result (Part 1)

	Differences			Fixed Effects			Alternative oil measures				
	None	Policy- vol	Falsification w/other bid items	Firm f.e.	No month f.e.	State- year f.e.	State- month f.e.	Quarter f.e.	Implied vol	26- week hist vol	5- month CL
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
$\mathbf{I}_{Kansas_j} \cdot \mathbf{I}_{Post Policy_t} \cdot Vol_t^{oil}$			.058** (.024)	-.18*** (.039)	-.15*** (.037)	-.21*** (.043)	-.1** (.047)	-.14*** (.037)	-.36*** (.069)	-.14** (.067)	-.13*** (.035)
$\mathbf{I}_{Post Policy_t} \cdot Vol_t^{oil}$		.68*** (.042)	-.14*** (.028)	.77*** (.044)	.79*** (.043)	.67*** (.059)	.047 (.49)	.13 (.087)	.65*** (.05)	.33*** (.039)	.75*** (.041)
$\mathbf{I}_{Kansas_j} \cdot \mathbf{I}_{Post Policy_t}$			-.12 (.078)	.53*** (.13)	.49*** (.13)	.35** (.14)	.33** (.15)	.45*** (.12)	1.2*** (.25)	.44** (.22)	.4*** (.12)
$\mathbf{I}_{Kansas_j} \cdot Vol_t^{oil}$			-.11*** (.02)	.047 (.032)	.044 (.031)	.067** (.029)	.00044 (.033)	.04 (.03)	.21*** (.05)	.096 (.059)	.019 (.029)
Vol_t^{oil}	.052*** (.013)	-.00021 (.0083)	.0013 (.0084)	-.0038 (.0087)	.0043 (.0084)	.016 (.01)	.19*** (.067)	.02 (.014)	-.019 (.023)	-.0073 (.015)	.0038 (.0097)
\mathbf{I}_{Kansas_j}	.11*** (.01)	.1*** (.01)	.45*** (.07)		-.029 (.1)			-.042 (.095)	-.62*** (.18)	-.21 (.19)	.046 (.096)
$\mathbf{I}_{Post Policy_t}$	.1*** (.03)	-.2*** (.12)	.42*** (.097)	-.23*** (.14)	-.24*** (.14)	-.18*** (.18)	.56 (1.7)		-.2*** (.18)	-.93*** (.15)	-.22*** (.13)
$\ln price_t^{oil}$	.059** (.03)	.28*** (.032)	-.093*** (.021)	.28*** (.036)	.31*** (.028)	.32*** (.036)	.31* (.16)	.21*** (.048)	.27*** (.029)	.24*** (.031)	.26*** (.03)
Controls [†]	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y
Month-of-year f.e.	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
County and year f.e.	Y	Y	Y	N	N	N	N	N ^{††}	Y	Y	Y
N	6111	6111	6111	6111	6111	6111	6111	6111	6111	6111	6111
R ²	0.912	0.921	0.989	0.925	0.921	0.922	0.938	0.938	0.921	0.916	0.921

Note: This table reports regression estimates of the effect of the risk removal policy on an additional unit of historical oil price volatility in Kansas vs. Iowa after vs. before the policy, using variations on Equation 3. The dependent variable is the log bitumen item bid. [†] Unreported controls are log total non-bitumen bid, log bitumen tons proposed, log paver miles to project, average total bid in the auction, and the number of bidders. ^{††} County f.e. included. Standard errors clustered by firm. *** p < .01.

Table 8: Further Robustness Tests of Main Result (Part 2)

Dependent variable: Log bitumen bid	Error Cluster Assumptions			Percentile volatility	
	Firm-month of year clusters	Robust (none)	Month clusters	Vol_t^{oil} 10 quantiles	Vol_t^{oil} 20 quantiles
	(1)	(2)	(3)	(4)	(5)
$\mathbf{I}_{Kansas_j} \cdot \mathbf{I}_{Post Policy_t} \cdot Vol_t^{oil}$	-.14*** (.044)	-.14*** (.04)	-.14* (.086)	-.015*** (.004)	-.0075*** (.002)
$\mathbf{I}_{Post Policy_t} \cdot Vol_t^{oil}$	.75*** (.049)	.75*** (.036)	.75*** (.11)	.37*** (.021)	.25*** (.014)
$\mathbf{I}_{Kansas_j} \cdot \mathbf{I}_{Post Policy_t}$	.44*** (.14)	.44*** (.13)	.44 (.29)	.048 (.029)	.043 (.028)
$\mathbf{I}_{Kansas_j} \cdot Vol_t^{oil}$	.034 (.038)	.034 (.034)	.038 (.077)	.0042 (.003)	.0018 (.0015)
Vol_t^{oil}	.00031	.00031	.00068	-.00045	-.00019
\mathbf{I}_{Kansas_j}	(.01)	(.0078)	(.031)	(.001)	(.00048)
$\mathbf{I}_{Post Policy_t}$	.0033 (.12)	.0033 (.11)	-.017 (.25)	.085*** (.019)	.089*** (.019)
$\ln price_t^{oil}$	-2.2*** (.16)	-2.2*** (.12)	-2.3*** (.34)	-2.2*** (.13)	-2.2*** (.13)
Controls [†]	.27*** (.029)	.27*** (.021)	.27*** (.065)	.27*** (.031)	.27*** (.031)
Month-of-year f.e.	Y	Y	Y	Y	Y
County and year f.e.	Y	Y	Y	Y	Y
N	6111	6111	6111	6111	6111
R^2	0.922	0.922	0.922	0.921	0.921

Note: This table reports regression estimates of the effect of the risk removal policy on an additional unit of historical oil price volatility in Kansas vs. Iowa after vs. before the policy, using variations on Equation 2. The dependent variable is the log bitumen item bid. [†]Unreported controls are log total non-bitumen bid, log bitumen tons proposed, log paver miles to project, average total bid in the auction, and the number of bidders. Standard errors clustered by firm. *** $p < .01$.

Table 9: Within-Kansas Estimates of Policy Effect by Firm Type

Dependent variable: Log bitumen bid

$X_j =$	Public vs. Private		High risk vs. Low risk	
	(1)	(2)	(3)	(4)
$\mathbf{I}_{X_j} \cdot \mathbf{I}_{Post\ Policy_t} \cdot Vol_t^{oil}$	.13*	.15*	-.16*	-.17*
	(.08)	(.085)	(.088)	(.098)
$\mathbf{I}_{X_j} \cdot \mathbf{I}_{Post\ Policy_t}$	-.39	-.42	.48	.49
	(.27)	(.28)	(.3)	(.32)
$\mathbf{I}_{Post\ Policy_t} \cdot Vol_t^{oil}$	.29***	.2***	.44***	.37***
	(.064)	(.054)	(.058)	(.075)
$\mathbf{I}_{X_j} \cdot Vol_t^{oil}$	-.031	-.04	.088	.09
	(.059)	(.069)	(.059)	(.078)
\mathbf{I}_{X_j}	.063		-.25	
	(.21)		(.21)	
$\mathbf{I}_{Post\ Policy_t}$	-.3	-.04	-.73***	-.51**
	(.21)	(.17)	(.19)	(.24)
Vol_t^{oil}	-.2***	-.15***	-.25***	-.21***
	(.05)	(.042)	(.051)	(.063)
Controls [†] , Month-of-year f.e.	Y	Y	Y	Y
County·year f.e.,	Y	N	Y	N
Firm f.e.	N	Y	N	Y
N	1442	1442	1404	1404
R^2	0.775	0.751	0.770	0.744

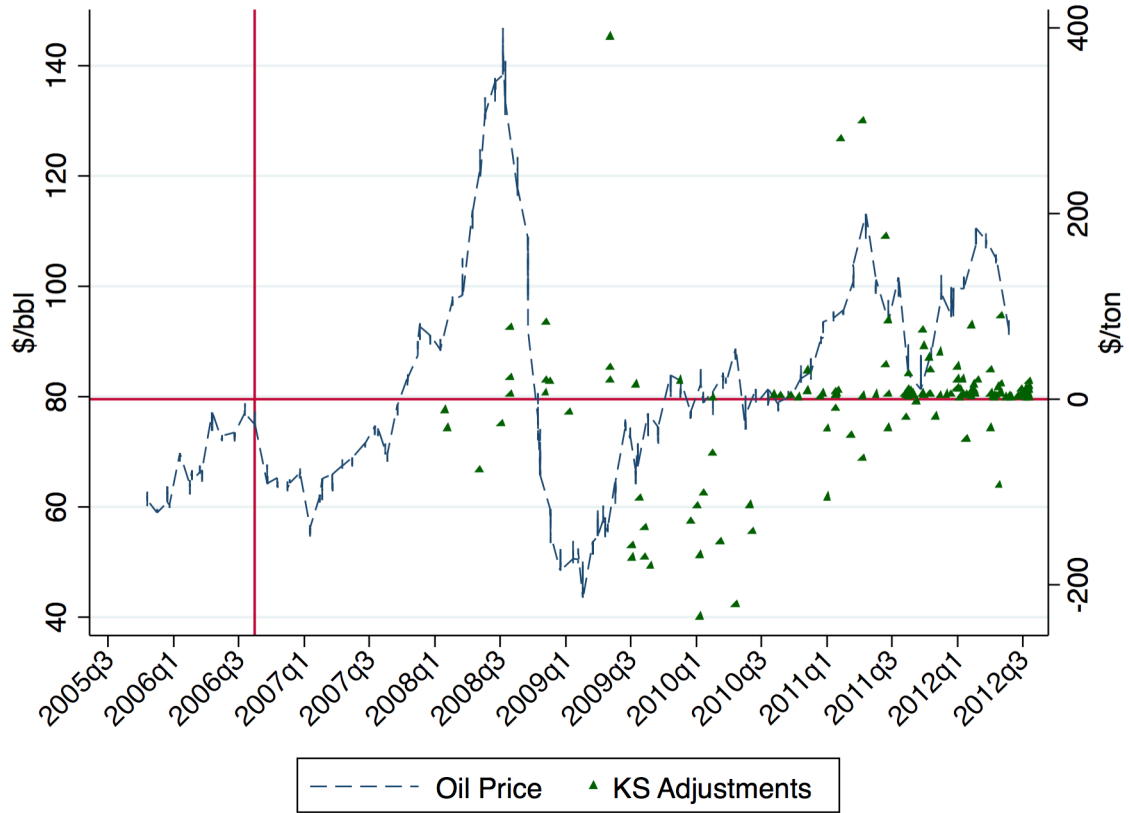
Note: This table reports estimates of how the policy affected different types of firms within Kansas. In columns I-II, $X_j = 1$ if the firm is public and 0 if private, and in columns III-IV, $X_j = 1$ if the firm is high risk, and 0 if not. Estimates are variants on Equation 3. [†]Unreported controls are log total non-bitumen bid, log bitumen tons proposed, log paver miles to project, average total bid in the auction, and the number of bidders. Standard errors clustered by firm. *** $p < .01$.

Table 10: Marginal Effect of Oil Price Volatility after the Policy

Dependent variable: Log bitumen bid				
	Paving only, not family-owned	Family-owned, not paving only	High risk, not family-owned	Family-owned, not high risk
	(1)	(2)	(3)	(4)
$\mathbf{I}_{Kansas_j} \cdot \mathbf{I}_{Post\ Policy_t} \cdot Vol_t^{oil}$	-.21*	-.11**	-.22***	-.17***
	(.1)	(.045)	(.055)	(.058)
$\mathbf{I}_{Post\ Policy_t} \cdot Vol_t^{oil}$	.78***	.88***	.48***	.71***
	(.11)	(.086)	(.13)	(.041)
$\mathbf{I}_{Kansas_j} \cdot \mathbf{I}_{Post\ Policy_t}$	.71**	.32*	.65***	.55***
	(.34)	(.16)	(.17)	(.19)
$\mathbf{I}_{Kansas_j} \cdot Vol_t^{oil}$	-0.0043	-0.029	-0.014	.06
	(.093)	(.048)	(.058)	(.043)
Vol_t^{oil}	-.018	.026	.11**	.0029
	(.024)	(.02)	(.053)	(.0098)
\mathbf{I}_{Kansas_j}	.16	.25	.17	-.089
	(.31)	(.16)	(.2)	(.14)
$\mathbf{I}_{Post\ Policy_t}$	-2.5***	-2.6***	-1.4***	-2.1***
	(.34)	(.24)	(.37)	(.13)
$\ln price_t^{oil}$	.12**	.33***	.17***	.27***
	(.057)	(.078)	(.038)	(.042)
Controls [†]	Y	Y	Y	Y
Month-of-year f.e.	Y	Y	Y	Y
County and year f.e.	Y	Y	Y	Y
N	753	1372	509	3230
R^2	0.915	0.899	0.869	0.924

Note: This table reports regression estimates of the effect of the risk removal policy on an additional unit of historical oil price volatility in Kansas vs. Iowa after vs. before the policy, using variations on Equation 3. [†]Unreported controls are log total non-bitumen bid, log bitumen tons proposed, log paver miles to project, average total bid in the auction, and the number of bidders. Standard errors clustered by firm. *** $p < .01$.

Figure 1: Price Adjustments and Oil Price



Note: This figure shows Kansas price adjustments based on oil price changes after the policy.

Figure 2: Firm Z Project Locations Coded by Bitumen Supplier

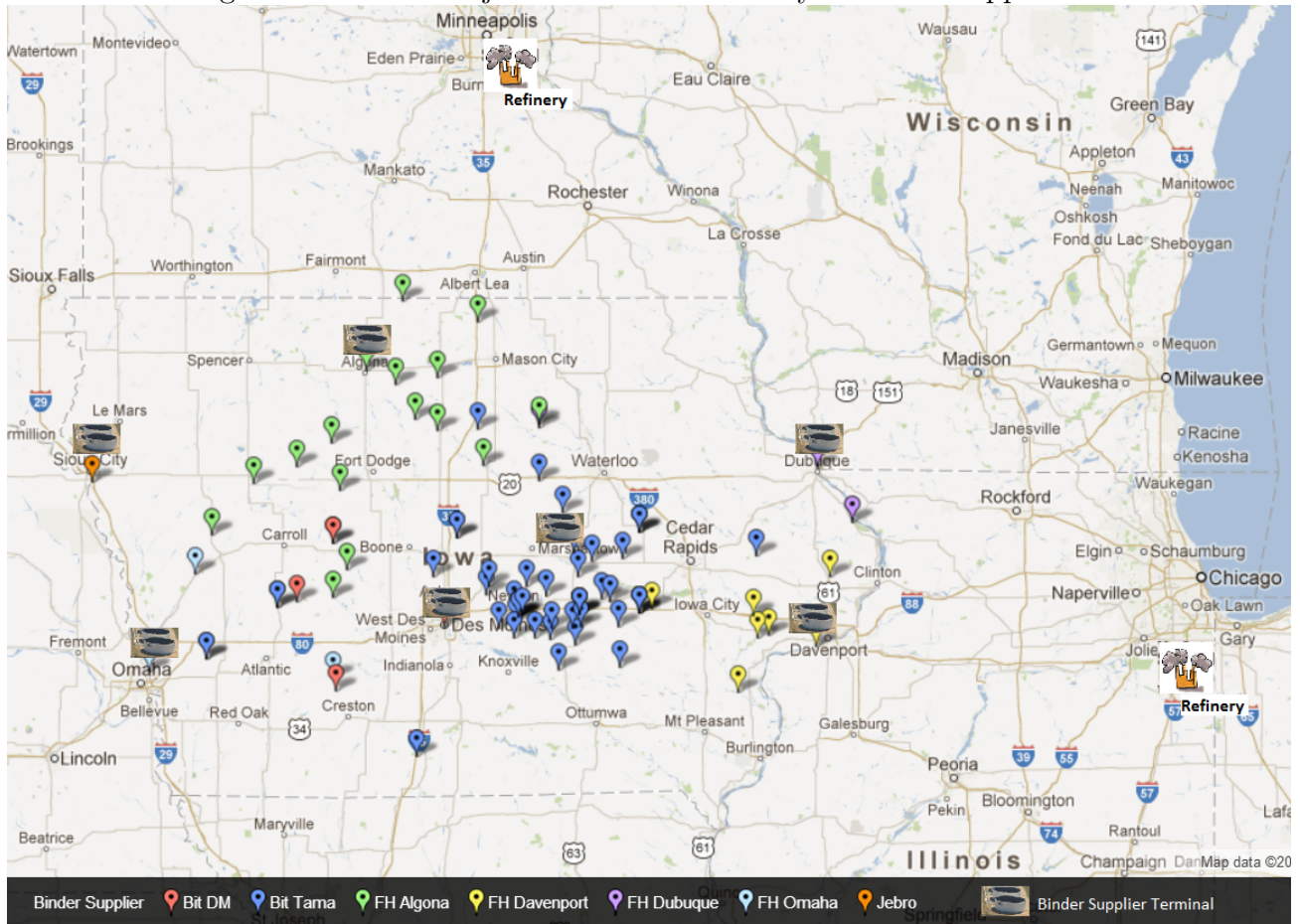
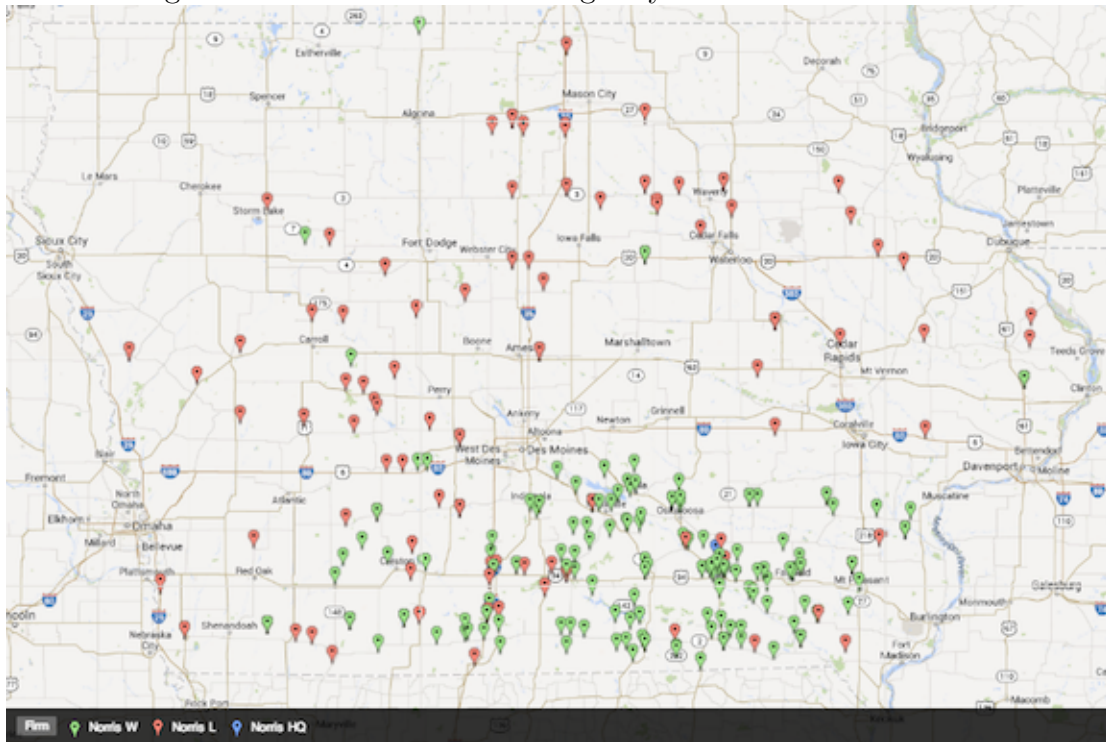
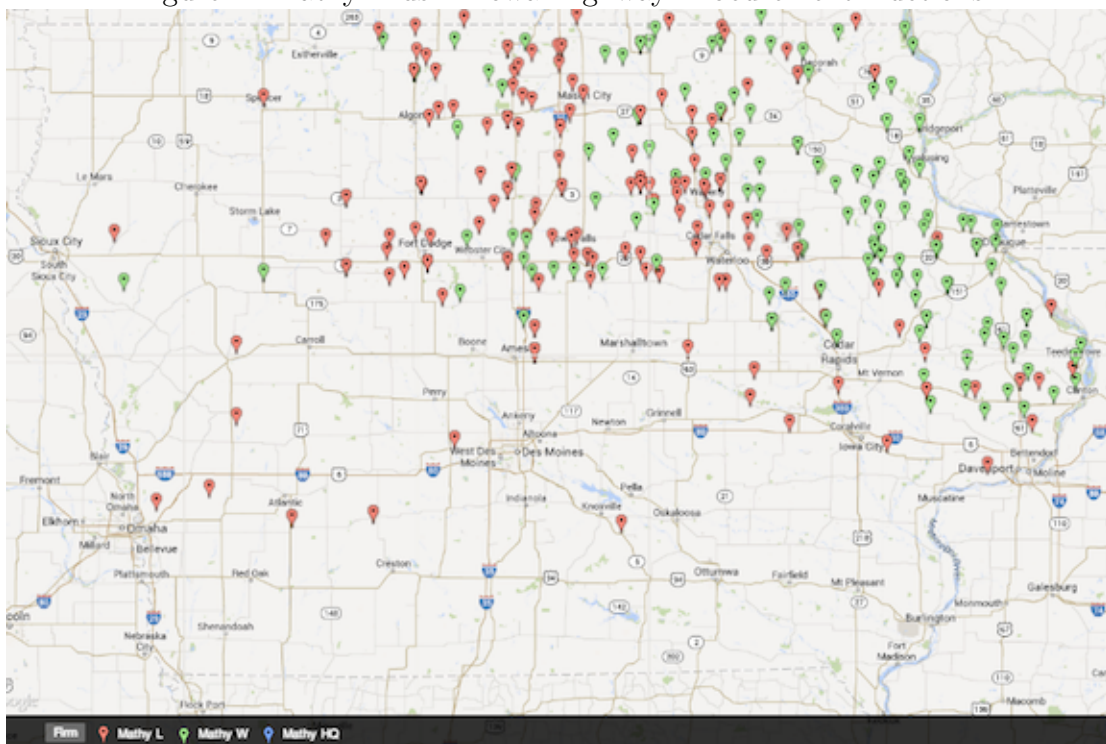


Figure 3: Norris Bids in Iowa Highway Procurement Auctions



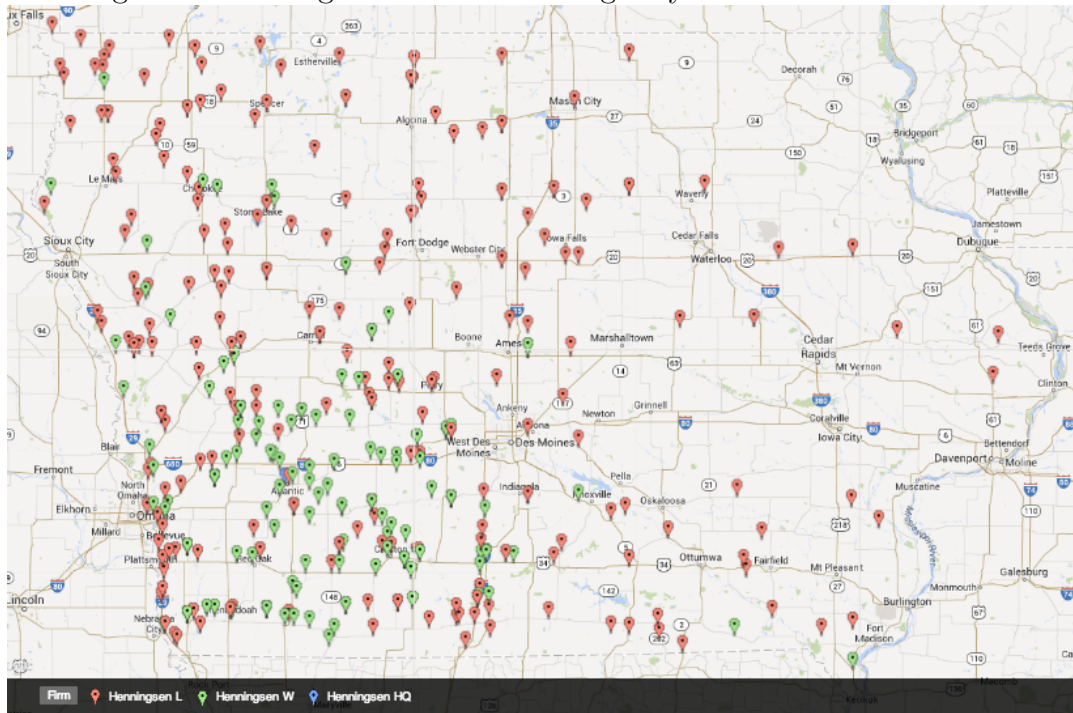
Note: This figure shows the location of one firm's auction wins (green) and losses (red).

Figure 4: Mathy Bids in Iowa Highway Procurement Auctions



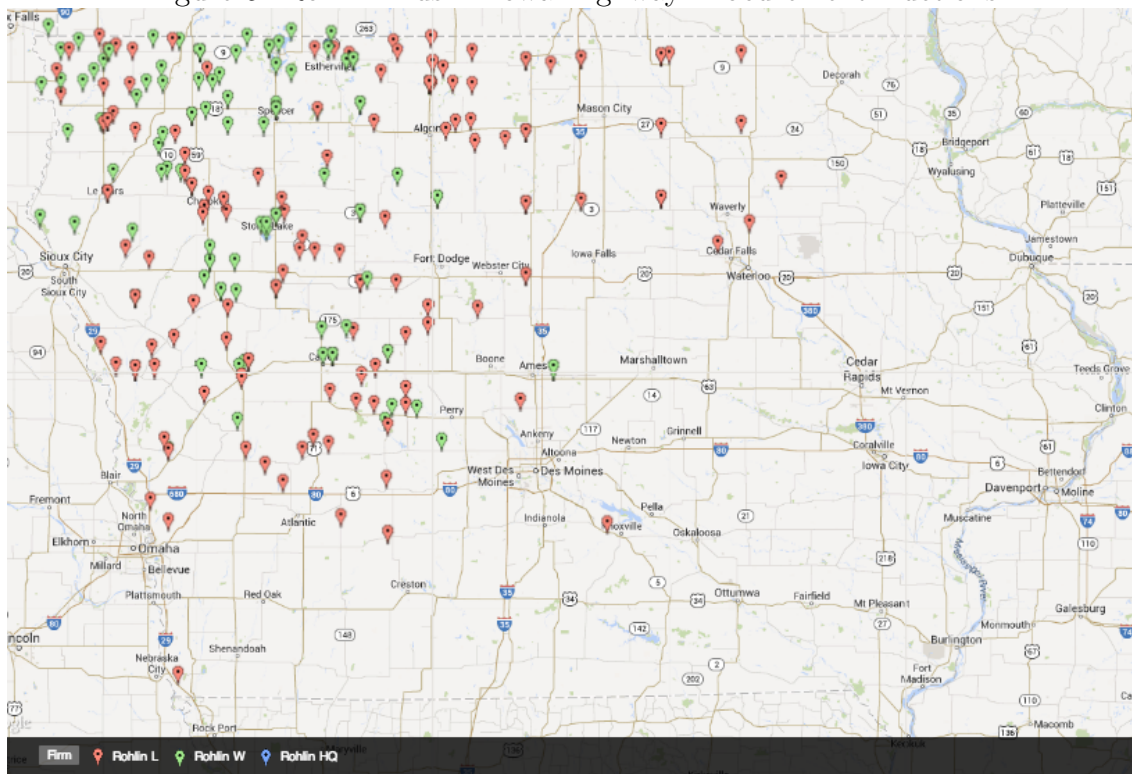
Note: This figure shows the location of one firm's auction wins (green) and losses (red).

Figure 5: Henningsen Bids in Iowa Highway Procurement Auctions



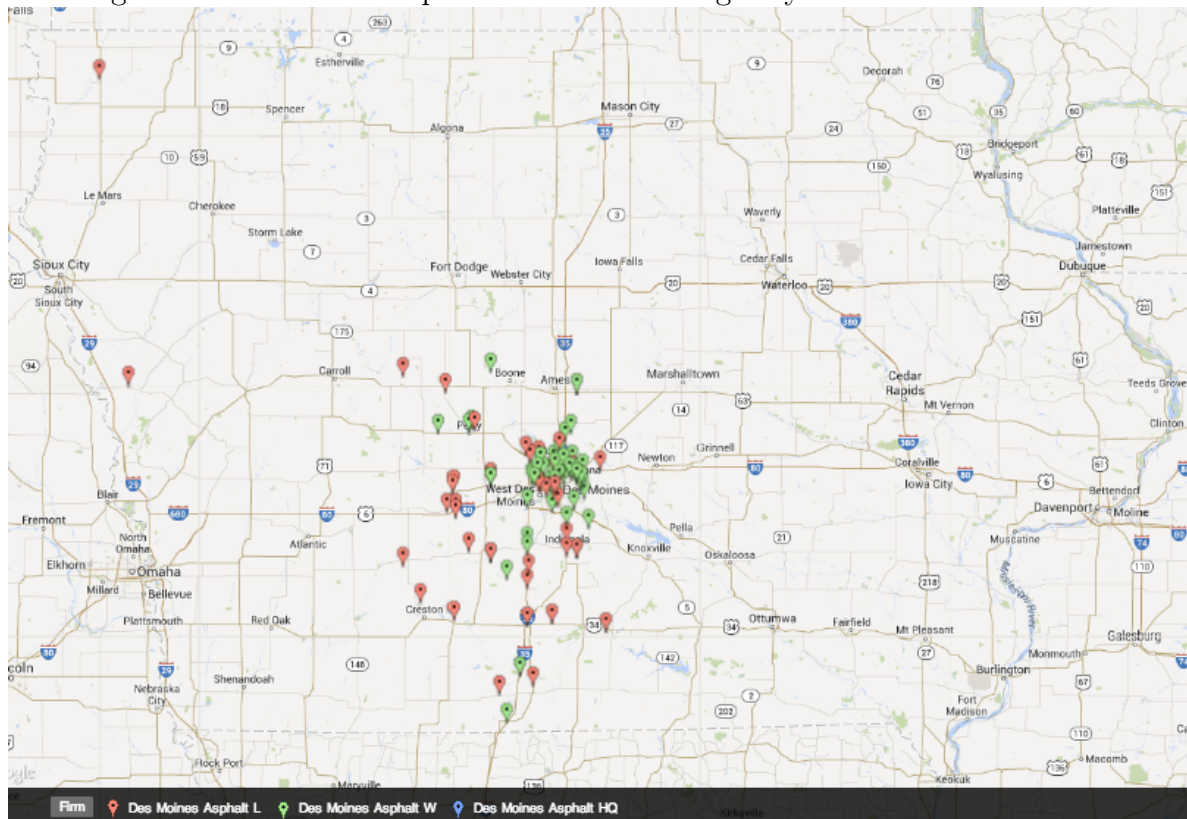
Note: This figure shows the location of one firm's auction wins (green) and losses (red).

Figure 6: Rohlin Bids in Iowa Highway Procurement Auctions



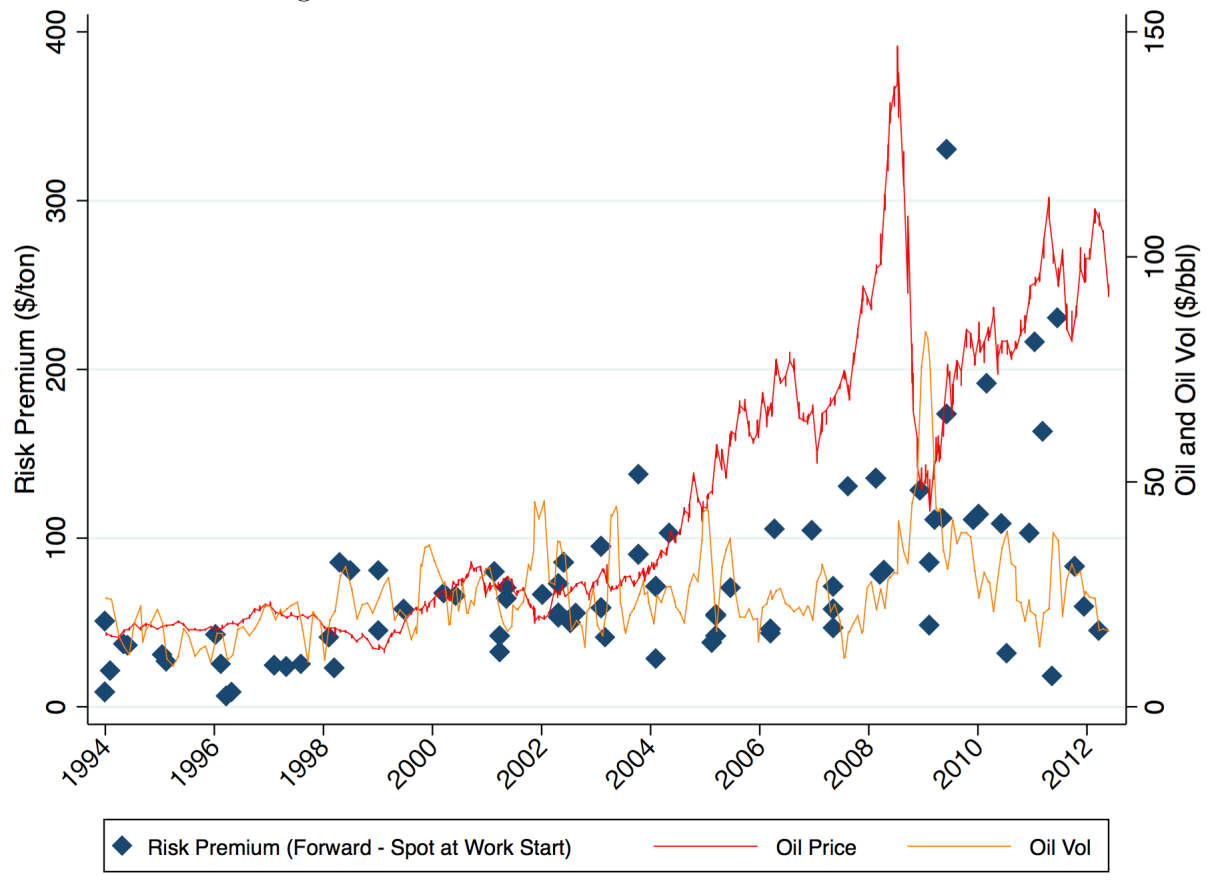
Note: This figure shows the location of one firm's auction wins (green) and losses (red).

Figure 7: Des Moines Asphalt Bids in Iowa Highway Procurement Auctions



Note: This figure shows the location of one firm's auction wins (green) and losses (red).

Figure 8: Firm Z Forward Contract Risk Premiums



Note: This figure shows the risk premiums embedded in Firm Z's forward contracts, which are signed at the time of the auction (typically in winter). I subtract the spot price in the week work starts (typically in the summer) from the forward contract price to get the risk premium.

Figure 9: Rolling Crude Oil Betas



Note: This figure shows rolling crude oil betas for a strict CAPM regression using front-month WTI oil futures, S&P 500, and 3 month T-Bills. Each point is a beta estimated for the previous 1, 3, 5 or 7 years.