Ohio School Milk Markets: an Analysis of Bidding

Porter and Zona

1999

- Ohio School milk supply auction: Relatively easy to collude.
- State of Ohio vs. Louis Trauth Dairies Inc. et al. 13 dairies were charged with collusion in school milk auction from 1980 to 1990.
- Bidding and other data were collected from school districts around Ohio.
- Empirically analyze the data on whether dairies submitted any bids and the level of bids separately for dairies that were defendents (treatment group) and those that were not (control group). See whether they systematically behaved differently, and how.
- Control group firms: bids are lower at nearby districts and higher at a more distant districts. This is natural since transportation cost is high.
- Treatment group (defendants): Submit bids at local auction and also bids at faraway districts. Nearby bids are higher and the distant bids lower.

- 600 Ohio school districts independently solicit bids for annual contracts for milk delivery.
- Bids include prices for various products. Coolers, straws and napkins required or not, allowing prices to vary with raw milk or not.
- Demand for school milk is inelastic of price, and main cost variation for supply is the distance from the school to its nearest dairy processing plant.

Favorable Conditions for Cartel Formation

- Demand is very predictable.
- Firms only bid on prices. Firms that bid and its prices are publicly known. It is easy to detect deviation of the cartel.
- School districts auction annually at different times during summer. Easy to retaliate against deviation from cartel agreement.
- Same firms bid in multiple districts: Easier to allocate cartel agreed contracts among firms.
- Active communication among dairies through dairy associations, through retail store visits to obtain price lists.
- Price bids are in discrete price categories: Helps price collusion.

Competitive Bids

A firm will bid in a district if the expected probability of winning is high and the return when winning the bid is high. They will depend on.

- Transportation cost: distance to the school.
- Distributor or a processor (plant nearby or not) of milk.
- Closest supplier (i.e. likey to be the lowest cost supplier) or not.
- Second closest supplier or not.
- Whether school district is large or small.
- Details of the contracts are favorable or not (coolers, indexed with raw milk price)

Probit Estimation Results of Bidding

The data is on firms that were not the defendants of the lawsuit (control group)

$$D_{ijt} = 1\left(X_{ijt}\beta_0 + X_{it}\beta_1 + X_{jt}\beta_2 + \epsilon_{ijt} > 0\right)$$

X_{ijt}: District i supplier j characteristics (distance between the two, etc)
X_{it}: District i characteristics.
X_{jt}: Supplier j characteristics.
ϵ_{ijt}: error term: normally distributed

- Bidder fixed effects: Include bidder dummies in the probit regression instead of X_{jt}
- Bidder district fixed effects: Include bidder and district dummies in the probit regression instead of X_{it}, X_{jt}.

Estimation Results

- Processors more likely to submit bids then distributors.
- Firms are more likely to submit bids in one particular direction, perhaps along a supply route.
- Firms are more likely to submit nearby district bids.
- Discricts that require coolers and straws get less bids.

TABLE 4 Estimated Coefficients: Control Group Submission Model

Variable Name	Base Probit Submission Model		Bidder Fixed-Effect Submission Model		District and Bidder Fixed-Effect Submission Model	
	Coefficient	*t*-statistic	Coefficient	*t*-statistic	Coefficient	*t*-statistic
	(a)	(b)	(c)	(d)	(e)	(f)
Constant	−2.5599	−23.3	NA		NA	
Direction	1.1461	16.1	1.2726	15.5	1.3600	8.4
Direction*distance	.0056	3.6	.0130	7.0	.0286	7.6
Processor*direction	−.9047	−6.1	−1.0068	−4.6	−1.1091	−2.6
Processor*direction*distance	.0319	11.1	.0315	5.9	.0486	4.7
Processor*distance	−.0353	−15.4	−.0475	−13.2	−.0549	−7.8
Distance	−.0155	−10.1	−.0230	−12.4	−.0432	−11.4
Processor	1.7782	18.6	1.6897	10.4	1.5505	5.0
Size	27.8765	17.0	12.2028	4.6	18.9323	4.0
Size*distance	.1664	3.2	.1223	2.1	.0655	.6
(Size*distance)^2	−.0335	−4.5	−.0008	−.1	.0022	.2
Closest	.3707	9.9	.3300	7.3	.2028	2.3
Second closest	.0892	1.6	.1890	3.0	−.0136	−.1
District enrollment	.0000	−4.2	.0000	−3.4	.0003	2.0
No cooler	.1419	2.3	.1601	2.4	.2971	1.0
Cooler provided	.0920	2.9	.0823	2.3	.1123	1.0
Fixed bid	−.0533	−1.2	.0156	.3	.0089	.0

Bid Level Contingent on Submission

The data is on the control group.

$$Y_{ijt} = X_{ijt}\beta_0 + X_{it}\beta_1 + X_{jt}\beta_2 + \lambda(Z_{ijt}\gamma) + \epsilon_{ijt}$$

$\lambda(Z_{ijt})$: Inverse Mill's ratio for sample selection bias correction.

- Bids increase with distance.
- Distributers' bids are lower than processors.
- Firms closes to the district have competitive advantage.
- Firms that are likely to submit bids are more likely to bid low.
- Escalating bids are lower than fixed bids.

TABLE 5 Estimated Coefficients: Control Group Bid Level

Variable Name	Bid Model		Bidder Fixed-Effect Bid Model		District and Bidder Fixed-Effect Bid Model	
	Coefficient	*t*-statistic	Coefficient	*t*-statistic	Coefficient	*t*-statistic
	(a)	(b)	(c)	(d)	(e)	(f)
Constant	.1235	59.5	.1285	33.9	.1229	.0
Processor*distance	.0000	.6	.0001	2.9	.0001	2.5
Distance	.0000	2.3	.0000	.3	.0000	−1.4
Processor	−.0022	−3.1	−.0013	−.7	−.0040	−1.9
Closest	.0035	4.1	.0005	.6	.0010	.8
Closest*distance	−.0001	−2.3	.0000	−.1	.0000	.1
District enrollment	.0000	−3.2	.0000	−1.3	.0000	.0
Inverse Mills Ratio	.0017	2.9	.0016	2.6	.0021	3.5
No cooler	.0023	2.4	−.0004	−.5	−.0002	−.1
Cooler provided	.0008	1.5	.0013	3.2	.0006	1.0
Fixed bid	.0023	3.1	.0012	2.0	−.0012	−1.3
Escalator	−.0030	−3.5	−.0009	−1.3	.0009	.8
Straws not included	−.0004	−.2	.0004	.3	.0032	1.6
Straws included	−.0016	−2.4	−.0011	−2.1	−.0006	−.7
Delivery missing	.0017	1.1	−.0010	−.9	.0006	.3
Number deliveries	.0005	1.3	−.0005	−1.6	−.0001	−.1
Cooperative	.0013	.7	.0003	.2		
Geographic spread	.0000	−.5	.0000	−.9	−.0035	−1.9

Behavior of Defendants

- From the above regression, predict the bids of defendants given the control group coefficients.
- Compare the predicted bids and the actual bids of the defendants.
- Run the regression where the dependent variable is the difference between the actual and predicted bids.
- All Cincinnati dairies bid more on very close districts, i.e. less than 30 miles distance. Meyer and Trauth bid more frequently than the control group for districts that are very far away.
- Meyer and Trauth, bid levels are significantly negative function of distance. Remember that for control group, bid levels are a significantly increasing function of distance.

- When we derive the difference between predicted participation of defendants based on the congrol group estimates and their actual participation in bids in districts, then they are positively correlated. This is consistent with complementary bidding.
- Similarly, the residual, i.e. the difference between the actual bid price and the predicted bid prices are also positively correlated for the defendents. Complementary bidding.

TABLE 6 **Percent Deviations in Predicted and Actual Bid Submissions by Distance: Cincinnati Dairies**

Distance in Miles	Coors Brothers	Meyer	Louis Trauth
	(a)	(b)	(c)
0–10	24.2% >	5.6% >	7.0% >
10–20	42.9% >	8.2%	15.2% >
20–30	22.9% >	18.5% >	20.6% >
30–40	−17.1% <	18.6% >	.1%
40–50	−9.5% <	−2.2%	−4.3%
50–60	−6.0%	−5.5%	6.9%
60–70	−6.0%	−18.6% <	47.1% >
70–80	−4.9% <	−25.0% <	10.0% >
80–90	−2.4% <	−17.5% <	−2.5% <
90–100	−1.7%	−7.7% <	−11.8% <
100–110	−1.3%	30.7% >	8.7% >
110–120	−.6%	.5%	−4.2% <
120–130	−.5%	−.9%	−3.6% <
130–140	−.2%	−.3%	−2.0%
140–150	−.2%	−.1%	−1.2%

Notes: A "<" indicates that actual bidding was statistically significantly below the predicted level. A ">" indicates that actual bidding was statistically significantly above the predicted level. Standard error of each prediction was computed using $p*(1 - p)$ approximation to variance of a Bermoulli random variable. Probit model incorporating no fixed effects were used for these calculations. The other models present similar patterns.

TABLE 7 Estimated Coefficients: Cincinnati Dairies Bid Level

Variable Name	Coors Brothers		Meyer		Trauth	
	Coefficient	*t*-statistic	Coefficient	*t*-statistic	Coefficient	*t*-statistic
	(a)	(b)	(c)	(d)	(e)	(f)
Constant	.1194	5.6	.1327	30.0	.1219	23.8
Distance	.0012	2.2	−.0001	−1.6	−.0001	−2.4
Closest	.0315	1.8	−.0042	−1.7	.0026	.9
Closest*distance	−.0007	−1.4	.0001	2.1	.0000	.5
District enrollment	.0000	−.5	.0000	−2.4	.0000	−2.7
Inverse Mills Ratio	−.0093	−1.5	.0001	.1	.0016	1.1
No cooler	−.0013	−.2	−.0057	−2.6	.0041	1.5
Cooler provided	.0088	2.6	.0015	1.1	.0004	.2
Fixed bid	−.0067	−2.6	.0012	.9	−.0023	−1.7
Escalator	−.0004	.0	−.0007	−.3	.0035	1.2
Straws not included	−.0021	−.9	.0022	1.3	−.0008	−.5
Straws included	−.0072	−2.2	.0010	.7	.0013	.8
Delivery missing	−.0056	−.6	.0070	2.1	.0038	1.0
Number deliveries	−.0029	−1.1	.0028	2.6	.0010	.9
Cooperative	.0166	1.4	−.0014	−.4	.0011	.3
Geographic spread	.0000	−.4	.0000	.8	.0000	−.8
Variance of population	.0000	−.2	.0000	−.4	.0000	.2
1981 Indicator	−.0058	−1.4	.0090	−3.3		
1982 Indicator	.0073	1.7	−.0044	−1.6	.0178	5.1