

Untitled Project about K-12 Broadband Procurement

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The views expressed do not necessarily reflect the position of the State of New Jersey or the data provider.

The Federal E-rate

- U.S. Federal subsidy for K-12 internet, through Federal Communications Commission.
- Schools subsidized at 20-90% based on need and location.
- Schools required to follow strict rules for a competitive bidding process.
- The current funding cap is about \$4.75 billion.

Procurement in New Jersey

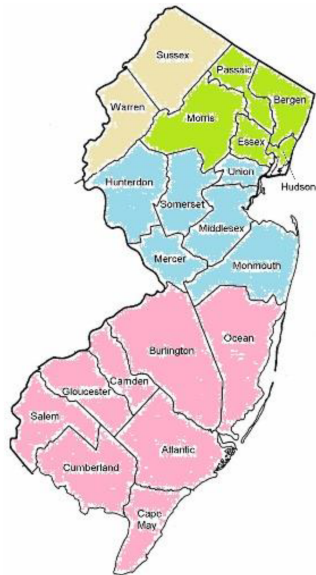
Typically, schools procure internet independently.

In 2014, NJ offered schools the option to join a consortium.

- Schools were split into four geographic regions.
- RFP winners gain right to supply every participating school in the region (qualify for Erate subsidy).

What happened?

- Participants experienced a *large decrease in price, and chose much higher bandwidth*.
 - Prices fell from \$30 Mbps to \$12 Mbps (monthly).
 - As a benchmark, I pay roughly \$0.15Mbps.
- Participation was small. Future rounds continue to improve.



Research Questions

What was the effect of the program?

- Prices are going down overall...
- Participation selection bias...
- Total savings compared to E-rate baseline?

What mechanism is most important?

- Exposure problem v. exclusives v. other?

How close is the program to first best?

Better 2nd-best design?

- Geographic considerations; package bidding; etc?

Economics of Broadband I

Why would bundling demand decrease prices/bids?

Costs of Broadband deployment.

- Hub and line model: large fixed costs associated with middle mile buildout.

Exposure Problem

- Any single school district may be un(less)-profitable.
- A group of close school districts can use the same hub – spread fixed costs out.
- Each single-school bid is an “exposed” trade in the parlance of Milgrom

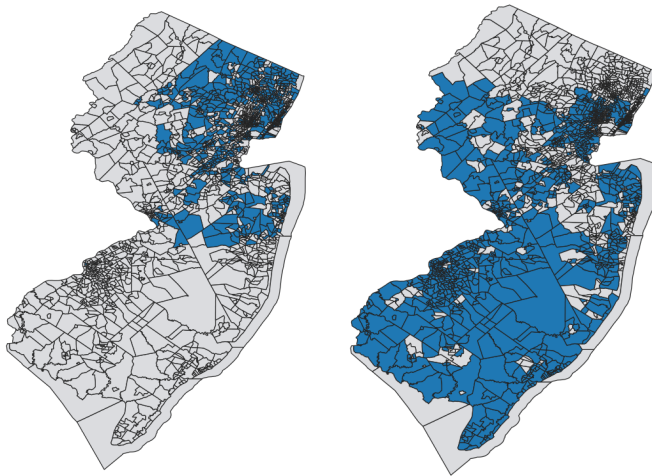
Definitions

- (1) An agent falls prey to exposure if their final allocation yields less utility than one of the previous allocations. (Goeree and Lindsay, 2020)
- (2) When competing aggressively for a package, global bidders may incur a loss when winning only an inferior subset. (Goeree and Lien, 2014)

Economics of Broadband II

Why would bundling demand decrease prices/bids?

Bidding for a bundled exclusive may bring competitors together.



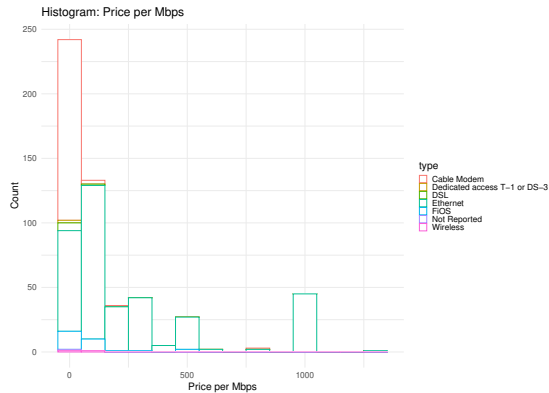
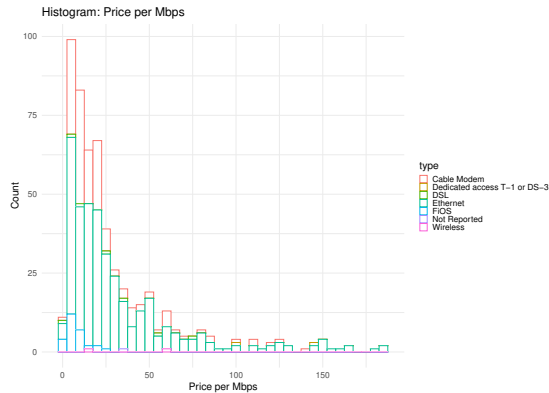
The New Jersey Broadband Consortium Program

- NJ reached out to schools to solicit interest.
- Schools provided Consortium with a list of requirements.
- Consortium advertised requirements to ISPs.
- Scoring auction, although basically the lowest price won, conditional on complete service.
- I will show you 2014 contracts (pre-period) and 2015 contracts (post period).

What was the bidding for?

- Broadband connection point and service through a regional hub.
- Direct internet service.
- Local WAN that connects all schools (intranet) and distributes internet.

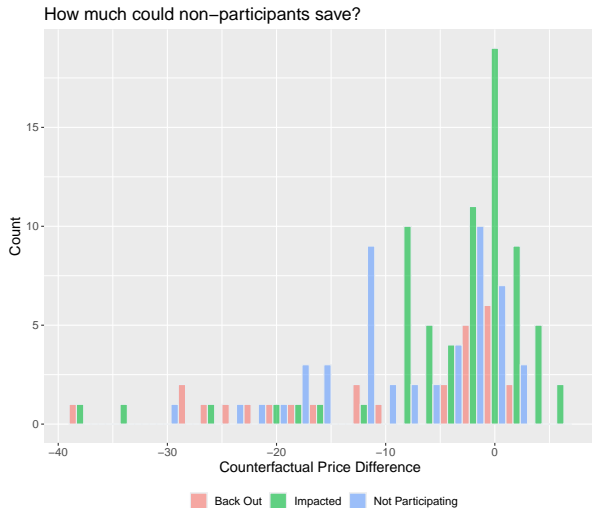
Distribution of Price and Mbps at Baseline



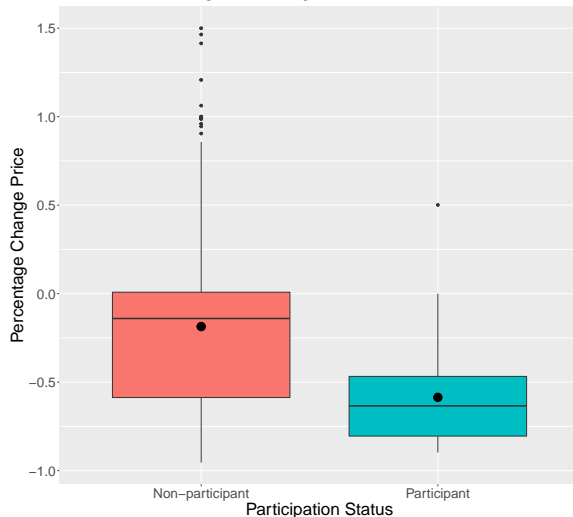
Observation is a school district or a private/charter school.

Most Non-participants Should Have Participated

For each non-participant, take the difference between their post price and the winning contract price.

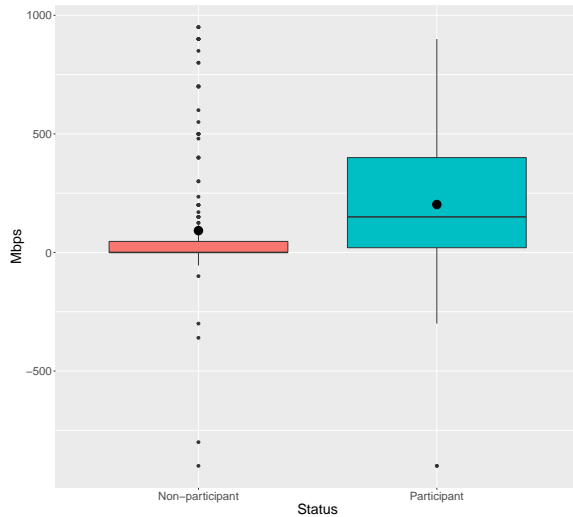


Prices fall more for consortium participants



- Only keep schools with same type of service pre-post (fiber/coax).

Participants choose higher bandwidth



Formal Tests: 2-period DiD

	<i>Dependent variable:</i>	
	\$ per Mbps	Mbps
	(1)	(2)
Non-Participant	18.978*** (0.779)	279.225*** (56.119)
Participant	19.045*** (1.983)	260.676* (142.926)
Post-consortium	-3.433*** (1.060)	79.061 (76.352)
Post x Participant	-8.516*** (2.867)	155.263 (206.612)
Observations	605	605
<i>Note:</i> *p<0.1; **p<0.05; ***p<0.01		

Problems with Testing Causal Effects

1. School districts self select into the program.
2. Differences in underlying broadband networks influence pre-prices and speeds.
3. Equilibrium effects of participation influence winning prices.

All of these cast doubt on the parallel trends assumption.

Solution 1: Sensitivity Analysis for Counterfactuals

DiD Invariance Assumption (p-trends): In absence of treatment, treated would have had the same change.

$$Y_{P,post}(0) = [Y_{NP,post}(0) - Y_{NP,pre}(0)] + Y_{P,pre}(0)$$

Manski and Pepper (2018) consider bounds of the form¹:

$$| [Y_{jd}(t) - Y_{je}(t)] - [Y_{kd}(t) - Y_{ke}(t)] | \leq \delta^{post}$$

In other words, the “trends” are not parallel by a violation of δ^{post}

¹see also Rambachan and Roth (2023, ReStud).

Bounds On Prices

	Time = 0		Time = 1	
	Treated	Not	Treated	Not
Participant	–	19	7	$f(\delta^{post})$ (??)
Non-Participant	–	19	–	15.5

Recall, the DiD estimate is $-(15.5 - 7) = -8.5$.

The participant group would have to have $8.5/3.5 = 2.5$ times the trend of non-participants in order to erase the point estimate. Seems like an unreasonably different trend.

- Participants have worse pre-existing broadband networks, so if anything, we might expect trend to be flatter.
- This rationalizes participation in the first place!

Solution 2: Bound the ATE directly

TBD

“Treatment Effect” on the Untreated

In the data, we observe the consortium price that would have been available to non-participants. (for sure, for those who backed out.)

- SUTVA might be violated here: large non-participants may affect the price (make it lower).
- Many reasons non-participants did not participate not related to expected benefit.

A Model of ISP Bidding

ISP Payoff

- \mathcal{W} : set of schools served.
- r_{ij} ISP i revenue from school j

$$\Pi_i(\mathcal{W}) = \sum_{j \in \mathcal{W}} r_{ij} - C(\mathcal{W})$$

where

$$C(\mathcal{W}) = \left(\sum_{j \in \mathcal{W}} \tilde{c}_{ij} \right)^\gamma$$

Bidding

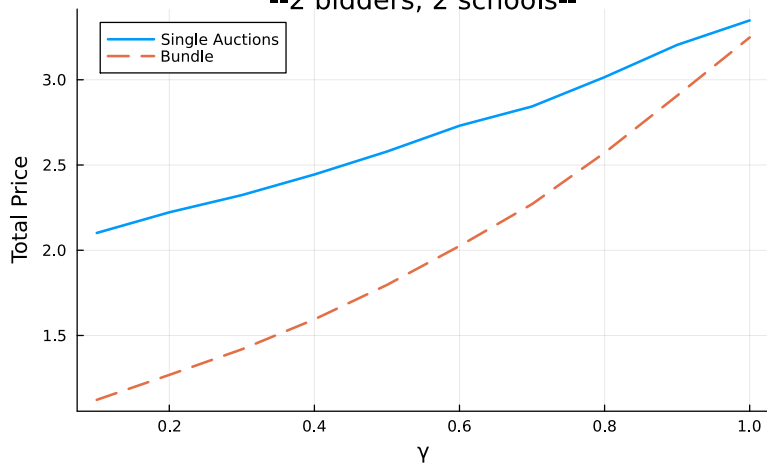
- case 1 Single school bidding. ISPs bid on schools independently and assume cost is c_{ij} , but actually costs reflect econ of scale after all winners are determined.
- case 2 Bidding on package of schools.

Simple Simulations

Change the strength of cost complementarities.

Single Auctions vs. Bundle Auction

--2 bidders, 2 schools--

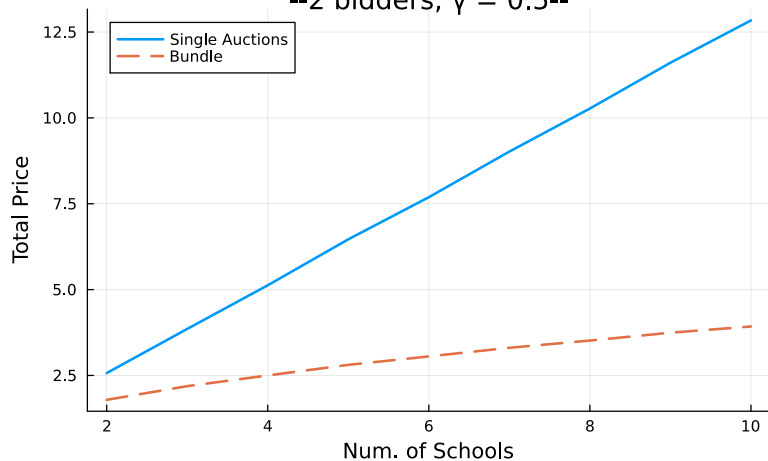


Simple Simulations

Change the number of schools.

Single Auctions vs. Bundle Auction

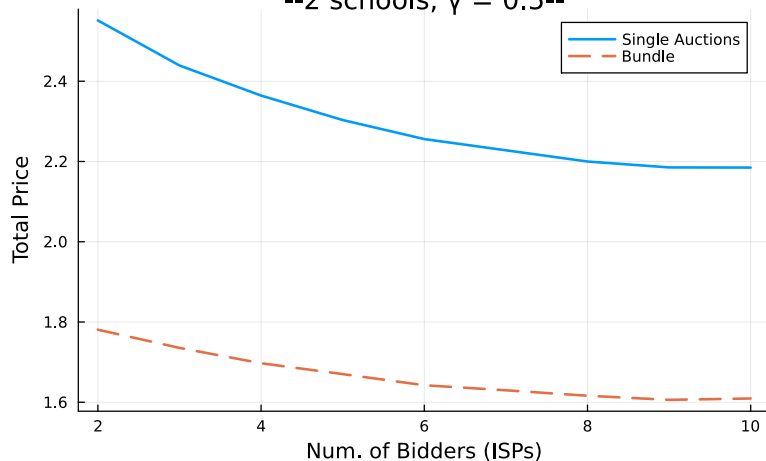
--2 bidders, $\gamma = 0.5$ --



Simple Simulations

Change the number of bidders.

Single Auctions vs. Bundle Auction
--2 schools, $\gamma = 0.5$ --



Final Thoughts

What is the change in “consumer” surplus from the program?

Compare savings from Consortium to benefit of baseline subsidies.

Add competitive effect to the model.

How to tell apart exposure from competitive effect in the data?

- Look at pre-treatment broadband networks and competition.

Use national data on Erate and networks to validate costs model and understand competition?