# Understanding State and Local Firm Subsidies: Slattery (2020) and Slattery and Zidar (2020)

Public Finance Reading Group

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# Introduction

Focus on two papers:

- Slattery and Zidar (2020)
  - Overview of state and local business tax incentives
- Slattery (2020)
  - Model of state/local bidding for firms
  - Builds toward welfare evaluation of subsidy competition: race to the bottom or welfare-enhancing?

Sneak peek of our takeaways:

- Great new data has breathed life into this topic
- Combination of clever empirical techniques (auctions, IO, etc)
- Jury is still out on the persuasiveness of results (particularly w.r.t. interpretation of welfare implications)

# Slattery and Zidar (2020) – State Tax Instruments

We'll begin with the overview from Slattery and Zidar (2020).

States possess three main tax instruments to incentivize businesses:

- Overall Corporate Tax Rate
  - Range from 0% to 10%
  - Explain surprisingly small portion of state revenue
- Breadth of Corporate Tax Base
  - Includes state investment credits, depreciation, and apportionment rules
  - Size of incentives tend to be positively correlated with state tax rate
- Firm-Specific Incentives
  - Focus of Slattery (2020) and the rest of our conversation today
  - Individualized plan designed to convince a firm to relocate (or stay)

# Slattery and Zidar (2020) – VW Example

To give a sense of these tax incentives, we'll review the 2008 agreement between Volkswagen and the State of Tennessee.

VW was given a $558 million package to locate in Chattanooga:

- The deal included $200m in property tax abatement, $200m in other tax credits, $81m in property transferred, $30m in worker training, $43m in highway and road construction spending.
    - Note: Unclear how we should think of training and transportation
- VW accepted the deal and promised to spend $2 billion and create 1,000 jobs. They decided on TN from a list of 12 finalist MSAs.

# Slattery (2020) – Primary Dataset

For her analysis, Slattery builds a dataset of deals like this VW case.

The dataset contains 500 deals between 2002 and 2017, with information on:

- Size of the tax incentive(s)
- Expected number of jobs created and planned investment
- Location of the runner-up (relevant later)

This is the best dataset created on the topic, but it is not perfect.

- Hard to value in-kind benefits like infrastructure spending, as well as regulatory exemptions (e.g. from environmental protections)
- No information on subsidy offer for runner-up (relevant later)

# Slattery (2020) – Information on Subsidies

What are the subsidies being offered?

- Average benefit is \$164m over 10 years
- Average number of promised jobs is 1500
- Cost per job is \$110,000 on average, with p10/p90 values of \$13,000 and \$723,000
- Big variation across industries. Auto plants promise many jobs w/ low cost per job. Chemicals promise fewer jobs but a lot of investment.

Which location characteristics are associated with higher subsidies? (See Table 2)

- Higher unemployment (need to do more to attract business?)
- No right-to-work-laws (higher labor costs?)
- Higher corporate tax rates
- Governor up to for re-election (we'll revisit)
- Together, these characteristics explain around 30% of subsidy variation

# Slattery (2020) – Model: Overview

- Goal of paper: estimate model of subsidy bidding process in order to conduct welfare analysis of state competition for firms
- Key feature of model (needed for identification): open-outcry private-valuation ascending (English) scoring auction
- Captures several salient features of real-world competition:
  - Firms care about more than just state subsidies (e.g. location-specific profit)
  - Multiple rounds of bidding
  - State governments generally know competitors' offers
  - States' valuations of firms are independent of one another
- Strategically equivalent to second-price auction:
  - The highest-value bidder (the state) wins the good (the firm), paying the price (payoff to the firm) of the second-highest-value bidder.

# Slattery (2020) – Model: Setup, Notation, and Timing

- Each state $s \in \{1, \ldots, S\}$ draws a private valuation for firm $i$, $v_{is}$ independently from $H(v(x_s, z_i))$
  - $x_s$: vector of location characteristics (e.g. per-capita income, housing prices, tax rates)
  - $z_i$: vector of firm characteristics (e.g. industry, jobs promised)
  - $v_{is}$ is "black box": corresponds to value to state-level decision-maker, not necessarily to aggregate individual WTP
- For each $s$, firm draws location-specific profit $\pi_{is}$
- States compete in open-outcry ascending auction by offering bids $\{b_{is}\}_{s=1}^{S}$
- Firm's total payoff from locating in state $s$ is $w_{is} = b_{is} + \pi_{is}$, so will choose to locate in state $s^* = \arg\max_s w_{is}$
- If firm chooses to locate in state $s$, payoff to state is $v_{is} - b_{is}$.
- **Ultimate goal: identify firm profits $\pi$ and distribution of state valuations $H(v)$.**

# Slattery (2020) – Model: Bidding Example

| State 1 | State 2 |
|---|---|
| $v_{1A} = 3,\ \pi_{A1} = 10, W = 13$ | $v_{2A} = 7,\ \pi_{A2} = 7, W = 14$ |

**State 1**

$v_{1A} = 3,\ \pi_{A1} = 10, W = 13$

$\vdots$

$b_1 = v_{1A} = 3$

$\pi_{A1} + v_{1A} = 13$

- - - - - - - - stop - - - - - - - -

**State 2**

$v_{2A} = 7,\ \pi_{A2} = 7, W = 14$

$b_2 = 3 + \varepsilon$

$\pi_{A2} + b_2 = 10 + \varepsilon$

$\vdots$

$b_2 = 6 + \varepsilon$

$\pi_{A2} + b_2 = 13 + \varepsilon$

# Slattery (2020) – Identification and Empirical Strategy

- As example shows, in equilibrium:

$$\underbrace{\pi_{\text{winner}} + b_{\text{winner}}}_{\text{payoff in winning location}} = \underbrace{\pi_{\text{runner-up}} + v_{\text{runner-up}}}_{\text{payoff in runner-up location}}$$

- **Recall: goal is to identify firm profits $\pi$ and distribution of valuations $H(v)$ in *every* state (not just winner/runner-up).**
- Challenges for identification:
  - No data on firm profits
  - No data on runner-up bids
- Leads to three-part empirical strategy:
  1. Recover parameters of firm profit function.
  2. Calculate payoffs in runner-up locations to identify full distribution of payoffs.
  3. Invert distribution of payoffs to recover distribution of state valuations $H(v)$.

# Slattery (2020) – Step 1: Firm Profits

- Functional form assumptions:
  1. $\pi_{is} = \beta_i x_s + \xi_{is}$, where $\xi \sim N(0, \sigma_\xi)$
  2. $v_{2i} = \alpha x_2 + \gamma z_i + \phi(x_2 \times z_i) + \epsilon_{2i}$
- Plugging in for $\pi_{i1}$, $\pi_{i2}$, and $v_{2i}$ and rearranging yields:

$$b_{1i} = \underbrace{\beta_i (x_2 - x_1) + (\xi_{i2} - \xi_{i1})}_{\pi_{i2} - \pi_{i1}} + \underbrace{\alpha x_2 + \gamma z_i + \phi (x_2 \times z_i) + \epsilon_{2i}}_{v_{2i}}$$

- Estimate this using OLS, leaving residual $\theta_i = (\xi_{i2} - \xi_{i1}) + \epsilon_{2i}$
  - Can't pin down $\epsilon_{2i}$ or $(\xi_{i2} - \xi_{i1})$ separately from estimated residual $\hat{\theta}_i$, so presents two sets of results: (i) all residual attributed to profits (so $\epsilon_{2i} = 0$); (ii) all residual attributed to valuations (so $\Delta\xi = 0$)
- Covariates used in estimation (by industry given small sample size):
  - Firms: industry, jobs promised, planned investment
  - Locations: corporate and income tax rates, number of establishments in same industry, wages, right-to-work indicator, share of population with BA, presence of research university, presence of airport, price of electricity

# Slattery (2020) – Step 2: Firm Payoffs

- Use estimates from Step 1 to predict total firm payoff in *runner-up* locations:

$$\hat{w}_{i2} = \hat{\pi}_{i2} + \hat{v}_{i2}$$

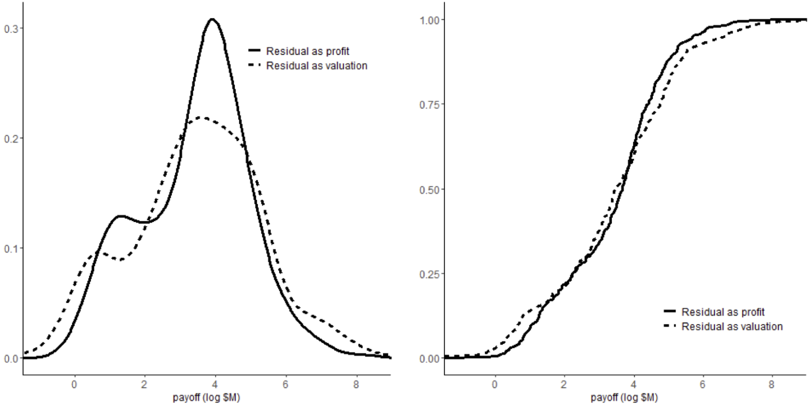
- Since we know (from the model) that this is the second order statistic of payoffs across locations $F^{(2:n)}(w)$, we can recover the *full* distribution $F(w)$ via the order statistic identity (Arnold, Balakrishnan and Nagaraja 1992; Athey and Haile 2002):

$$F^{(i:n)}(w) = \frac{n!}{(n-i)!(i-1)!} \int_0^{F(w)} t^{i-1}(1-t)^{n-i} dt$$

  - Here $i = 2$; since $F(w)$ depends on number of bidders $n$, presents results for $n = 12$ (average number of sites in consideration in data for which this is observed) as well as other values of $n$.

# Slattery (2020) – Step 2: Firm Payoffs

Figure 5: Firm Payoffs in the Runner-Up Location



# Slattery (2020) – Step 3: State Valuations

- Since $w_{is} = v_{is} + \pi_{is} \sim F(w)$, and since $v_{is} \sim H(v)$, we can recover $H(v)$ by inverting the distribution of firm payoffs:

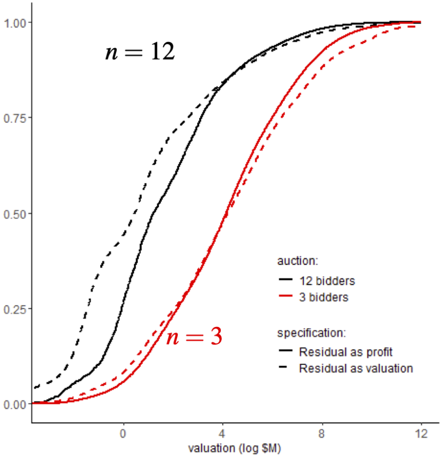
$$H(t) = \int F(t+\pi)g(\pi)d\pi$$

  (where $g(\pi)$ is the pdf of the distribution of firm profits).
- In practice, uses indirect inference: simulates location characteristics $x$, calculates $\pi$ using estimates from Step 1, and then estimates $H(t)$ using sample average:

$$\hat{H}(t) = \lim_{S\to\infty} 1/S \sum_{s=1}^{S} \hat{F}(t+\hat{\pi}(x))$$

# Slattery (2020) – Step 3: State Valuations

Figure 6: State and Local Government Valuations for Firms




**Valuation ($M): Varying Assumptions**

| # of Bidders | Residual Attributed to $\pi$ $25^{th}$ | $50^{th}$ | $75^{th}$ | $90^{th}$ |
|---|---|---|---|---|
| 3 | 9.0 | 62.2 | 375.1 | 1,823.5 |
| 6 | 1.8 | 11.7 | 84.4 | 602.8 |
| 10 | 1.0 | 4.4 | 28.8 | 196.0 |
| 12 | 1.2 | 4.0 | 24.4 | 139.7 |
| 20 | 0.8 | 2.1 | 12.9 | 47.0 |
| | Residual Attributed to $v$ | | | |
| 3 | 7.8 | 66.0 | 533.0 | 3,548.0 |
| 6 | 0.9 | 7.0 | 91.2 | 808.4 |
| 10 | 0.3 | 2.0 | 22.3 | 265.0 |
| 12 | 0.2 | 1.7 | 13.1 | 175.2 |
| 20 | 0.2 | 0.7 | 4.0 | 45.5 |

# Slattery (2020) – Determinants of State Valuations

Given estimates, can simulate counterfactual distributions of $H(v)$ to see how state valuations depend on location/firm characteristics (see Table 7):

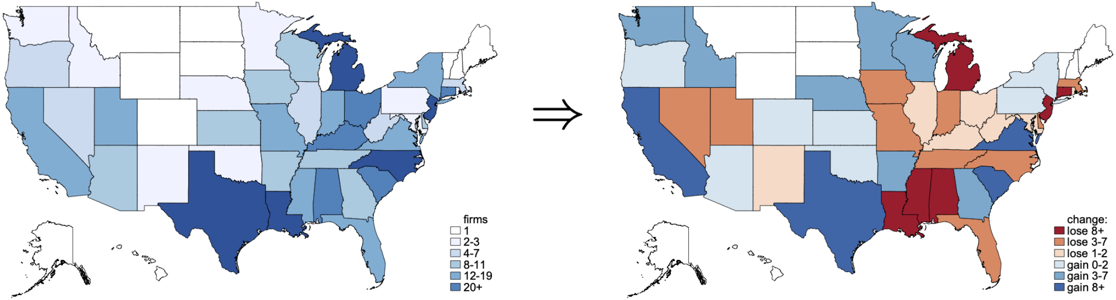
- Preferences vary over industry of firm: auto manufacturing $>$ scientific R&D $>$ wholesale trade/transportation
- Increasing number of promised jobs from 400 (25th percentile) to 900 (median) leads to increase of only about 10% in valuation
- Location that lost manufacturing jobs is willing to pay almost 50% more for high-tech manufacturing firm compared to location that is growing in manufacturing employment
- Low-employment-multiplier firm in place with low joblessness worth about 20% less than high-multiplier firm in high-joblessness place
- States with governors who face re-election willing to pay (at median) 30% more than states with term-limited governors

# Slattery (2020) – Counterfactuals

Consider the counterfactual where subsidies can't be offered. Assume firms pay state corporate taxes as currently set.

- Slattery calculates firm profits in each location using estimates from Step 1 above.
- Assuming all heterogeneity in bids is due to unobserved firm-location productivity match, then only 30% of firms stay in the winning location. 70% choose a new location, with 13% choosing the runner-up.
- If there is no unobserved productivity match, only 18% of firms stay in winning location.
- Results align with current state behavior: New York is seeking to ban subsidy competition and, based on simulation, would benefit from this ban. Alabama has won 13 subsidy competitions in the last 15 years and would lose from this ban.

# Slattery (2020) – Counterfactuals



# Slattery (2020) – Counterfactuals

What is the total impact on welfare? Slattery estimates that welfare (state valuation plus firm profit) drops 20% with the ban.

Table 8: Welfare Analysis

| Policy | Model | Subsidy ($B) | Simulated $v$ ($B) Baseline | No Politics | Sim. $\pi$ ($B) | Stay | Move to RU | Payoffs ($B) States | Firms |
|---|---|---|---|---|---|---|---|---|---|
| Competition | resid. as $v$ | 64.9 | 89.9 | 74.2 | 11.4 | - | - | 25.0 | 76.3 |
| Subsidy Ban | resid. as $v$ | 0 | 60.1 | 46.9 | 17.6 | 18% | 28% | 60.1 | 17.6 |
| Competition | resid. as $\pi$ | 64.9 | 83.1 | 73.2 | 15.2 | - | - | 18.2 | 80.1 |
| Subsidy Ban | resid. as $\pi$ | 0 | 51.1 | 41.2 | 25.9 | 30% | 13% | 51.1 | 25.9 |

# Slattery (2020) – Counterfactuals

Distributional implications are easier to see with the initial example.

| State 1 | State 2 |
|---|---|
| $v_{1A} = 3,\ \pi_{A1} = 10, W = 13$ | $v_{2A} = 7,\ \pi_{A2} = 7, W = 14$ |
| $\vdots$ | $b_2 = 3 + \varepsilon$ |
| $b_1 = v_{1A} = 3$ | $\pi_{A2} + b_2 = 10 + \varepsilon$ |
| $\pi_{A1} + v_{1A} = 13$ | $\vdots$ |
| - - - - - - - stop - - - - - - - | $b_2 = 6 + \varepsilon$ |
| | $\pi_{A2} + b_2 = 13 + \varepsilon$ |

How does the subsidy regime compare?

- With subsidies, State A offers 3 in subsidies, State B offers 6 + $\epsilon$. Winning State 2 gets 1 - $\epsilon$, winning firm gets 13 + $\epsilon$.
- Without subsidies, winning State 1 gets 3 and winning firm gets 10.
- So what happens when we allow subsidies as compared to the counterfactual where they aren't allowed?
  - State 2 gets 1 - $\epsilon$ from State 1. Do we care? Maybe not.
  - Firm gets 3 + $\epsilon$ at the expense of 2 + $\epsilon$ from State 1. Do we care? Maybe.

# Slattery (2020) – Counterfactuals

Other welfare considerations:

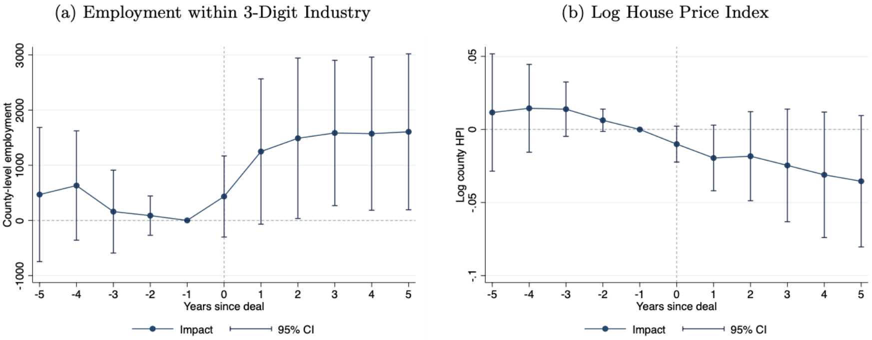
- Is the removal of term-limited governors enough? (Political donors? Election concerns for others?)
  - What would an Oster (2019) correction tell us?
- Accuracy of valuation (optimism? common value with uncertainty?)
- Does the partial equilibrium tell us much about the GE effect if states can move their tax rates?

# Slattery and Zidar (2020) – Effects of Firm Location Decisions

Accuracy of valuations is a big piece of the story. What does the evidence say on positive economic effects?

- Slattery and Zidar (2020) compare winner and runner-up counties in the spirit of Greenstone and Moretti (2003) on large plant openings:

Figure 4: The Effect of Winning a Firm on County-level Outcomes



# Slattery and Zidar (2020) – Effects of Firm Location Decisions

Now we look at the impact at the county level. We see very little:

Table 4: The Effect of Winning a Firm-Specific Deal on County-Level Outcomes

| | 3-D Ind. Employment (1) | Res. 2-D Ind. Employment (2) | Res. 1-D Ind. Employment (3) | Res. County-wide Employment (4) | Personal inc. (5) | log HPI (6) | Emp/pop (7) |
|---|---|---|---|---|---|---|---|
| *Panel A. Levels Estimates* | | | | | | | |
| Winner × Post | 1108.287** | 780.238 | 53.154 | -1920.430 | -1090.989 | N/A | -0.001 |
| | (539.686) | (1096.283) | (1928.740) | (5301.175) | (716.305) | N/A | (0.002) |
| Mean of outcome | 9326.605 | 15763.784 | 49393.076 | 2.80e+05 | 49826.006 | N/A | 0.470 |
| *Panel B. Log Estimates* | | | | | | | |
| Winner × Post | 0.149** | 0.026 | 0.030 | 0.003 | -0.005 | -0.040* | -0.002 |
| | (0.068) | (0.027) | (0.019) | (0.013) | (0.012) | (0.021) | (0.004) |
| Mean of outcome | 7.965 | 9.037 | 9.922 | 12.006 | 16.667 | 4.858 | -0.759 |

*Notes:* This table shows difference-in-differences estimates of the effects of winning a firm-specific deal on a variety of county-level outcomes. Employment data are from the Quarterly Census of Employment and Workers (QCEW, 1990-2017), HPI data are from the (Federal Housing Finance Agency, 2014), and employment-to-population figures are computed using BLS data for the numerator and BEA data for the denominator. Standard errors reported in parentheses and are clustered at the state level. *** $p < 0.01$, ** $p < 0.05$, *$p < 0.1$

The evidence on plant openings (Greenstone and Moretti (2003)) suggests there may be spillovers, but that doesn't appear to hold for this subset of subsidy-driven decisions.

# Our Takeaways

- Even with its limitations, data-collection effort by Slattery (2020) has opened up previously opaque area of research.
- However, persuasiveness of results, particularly w.r.t. welfare evaluation of subsidy competition, is less clear:
  - State valuations (”black box”) are not necessarily aggregated social welfare - leaving aside distributional concerns, may make large difference even for aggregate efficiency if state decision-makers incorrectly value externalities
- Important questions for future research:
  - Unpacking the black box: what drives valuations from the standpoint of state-level decisionmakers? (Lots of room for political economy here!)
  - Black box vs. crystal ball: how accurate are state valuations *ex-post*? Are states systematically over-optimistic?