

Subsidy Competition as an Auction

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In 2008, Volkswagen decided to locate a new assembly plant in Chattanooga, Tennessee. Volkswagen received a subsidy of over \$550 million, the result of a fierce competition between multiple states to win the new plant and associated jobs and investment—the neighboring state of Alabama offered at least \$400 million. This practice of competing for plants and headquarter locations is prevalent in the United States, where there have been 100s of large discretionary deals in the past 15 years, with notable recent examples including Amazon HQ2, the GE headquarters in Boston, and Tesla’s gigafactories in Nevada and Texas.

Is subsidy-giving good policy? Researchers want to be able to evaluate the practice of offering discretionary subsidies, and compare this to counterfactual regimes with regulations on subsidies. Two challenges make this a particularly difficult exercise. First, there are data limitations. Ideally, the researcher would observe the set of subsidy offers a firm receives, and then use that information to study the firm’s location choice. This data is rarely available, instead the researcher will observe the subsidy in the winning location, if that. The second issue is that the subsidy is an equilibrium outcome. State and local governments compete with subsidies and the firm makes a location decision, which is a function of the subsidy offers and the location characteristics. The location the firm would have chosen in absence of a subsidy is unknown.¹

Consider the Volkswagen deal in 2008. The researcher observes VW locating in Chattanooga for \$550 million. This is the result of Volkswagen’s location decision; some function which includes the final subsidy offer but also includes the local characteristics that dictate how profitable the company will be at that specific site. The observed subsidy is also a function of Tennessee’s willingness to pay for attracting Volkswagen to that location, the number of other competitors there were for the plant,

¹In many ways this is similar to class models of tax competition. The essential difference is that the government chooses a firm-specific tax (subsidy), instead of setting the tax for all firms in the jurisdiction. However, some of the core tensions remain: tax rates are in equilibrium and the tax base in absence of tax differentials is not observable.

and the payoffs the competitors they would be able to provide to Volkswagen. The researcher does not know Volkswagen’s location in some no-subsidy counterfactual, or whether Volkswagen creates more surplus in Tennessee than in that counterfactual choice.

Therefore, researchers need a framework in order to be able to evaluate how subsidies affect firm location choice how governments determine how much they are willing to pay for any given firm. I will argue that the appropriate framework is an auction. The press already describes subsidy competitions as bidding wars, an apt characterization of the process by which states and cities compete for an individual firm.² For the remainder of the paper, I will make the argument that the auction framework is not only appropriate, but a very useful framework to study subsidy giving.

There are a few key benefits to the auction approach. The first is that it is realistic. An auction closely approximates what happens in real life, which is a negotiation between a firm and multiple governments. Second, it is relevant. In the empirical auctions literature the objective is to recover the valuation of bidders. This is a policy relevant object in the subsidy competition—how much is a government willing to pay for a firm? If we have the distribution of government valuations, we can start answering questions about how governments determine willingness-to-pay, and whether or not this willingness-to-pay aligns with realized benefits. Therefore, we can rely on the empirical auctions toolkit to recover the distribution of willingness-to-pay.

Third, the auction toolkit is not data intensive: researchers can learn a lot from limited data. In an auction, the transaction price is usually sufficient to recover the full distribution of bidder’s valuations. Therefore, it is a good fit for the subsidy competition setting, where researchers only observe winning subsidies, not the full set of offers.

Lastly, once the researcher estimates a structural auction model, they are able to evaluate policy counterfactuals. This is an area where there is little policy experimentation. Every state in the U.S. allows subsidy-giving, and although regional or nationwide subsidy “truces” are often proposed, they are rarely realized (see Kim, 2023, for an exception). Therefore, policy counterfactuals are of great interest to policymakers: How would the distribution of economic activity change if the federal government limited states’ abilities to offer subsidies? What if a set of neighboring states agreed to stop competing for firms, how far would that go? Studying these type of policy proposals necessitates a structural model.

²For example: “Amazon Plans Second Headquarters, Opening a Bidding War Among Cities” in the New York Times on September 7, 2017.

I am not the first to propose an auction framework as a useful tool to study subsidy competition. Black and Hoyt (1989) and Martin (2000) explicitly model subsidy competition as an auction, and provide theoretical motivation for my approach (Slattery, 2022). In contemporaneous work, Kim (2020) estimates a subsidy competition game using a first-price private value sealed-bid auction. Similarly, Mast (2020) estimates a model in which New York counties compete for mobile establishments, and models the bidding process as a first-price scoring auction with common values.³

The paper proceeds as follows. First, I will review some backgrounds on auctions, and use that framework to motivate the type of model that I find best fits the institutional details of subsidy competition between states in the U.S. (Slattery, 2022). Next, I provide more details on that model, and then show two approaches to estimation, discussing drawbacks and benefits to each. Lastly, I conclude with a discussion of feasible counterfactual analyses and thoughts for future work.

1 Auction Framework

In an auction, bidders compete for a good (or service). Each bidder has some information on how much they value the good. They use that information to formulate their bids, and the specific auction rules allocate the winner and determine the payment.

The objective of the empirical auction literature is to recover the bidders' valuations. The auction rules, or the game, give way to an optimal bidding strategy that is dependent on the private information each bidder has about their valuation. Therefore, equilibrium theory gives us a way to map private information to bids. Then, once we recover bidders' valuation, we can infer welfare, and predict changes in the equilibrium if we changed the environment of the game.

1.1 Choosing an Auction Type

The tools from the empirical auction literature are dependent on auction type. Auctions can differ in both their format and their information structure. Therefore, the first thing we must do is to determine the appropriate auction to approximate subsidy competition.⁴

³The auction framework is far from the only useful approach. For example, Ossa (2018) applies a quantitative trade model to study state governments incentives to offer subsidies, in the aggregate.

⁴Readers interested in leaning more about empirical auctions will find the Handbook of Industrial Organization chapter (Hortagsu and Perrigne, 2021) to be a useful starting point.

1.1.1 Standard Auction Formats

An auction format is generally defined by an allocation and payment rule. In the first price sealed bid auction, everyone writes down their bid, submits it to the auctioneer, and then the person with the highest bid wins, paying the price they wrote down. In the second price sealed bid auction, again all the participants write down their bid, submit to the auctioneer, and the person with the highest bid wins, but pays the price of the second highest bid.

Other common formats include descending and ascending price open outcry auctions. The descending price auction (Dutch) starts at a very high price, and the price descends until the first bidder agrees to the price, winning the auction. Alternatively, in the ascending price open outcry (English) auction the auctioneer starts at a low price, and then accepts increasingly higher bids from bidders. Bidders are able to bid multiple times, and the auction ends when there is only one bidder remaining willing to pay the price.

In some auctions, it is not the highest price that wins, but the highest score. The scoring auction is used when the bids are multi-dimensional. For example, if a contractor bids on a project, the bid could have a price component as well as some quality components, like their past history completing similar projects, and their estimated time horizon. In that case, the contractor with the highest “score” would win.

1.1.2 Information Structure

The other important piece that will govern equilibrium strategy in auctions is the assumptions about bidders’ valuations. In an independent private value (IPV) model a bidder’s valuation of the good is only a function of their own, independent, information. Therefore, a bidder’s valuation is *private* as it does not affect it’s competitors’ valuation.

Alternatively, in a common value auction, all of the bidders have the same valuation for the good, but have only an imperfect signal of what that value would be. The typical example here is an auction for an oil lease—each company has an estimate of the amount of oil in the tract, but this is only an estimate. The actual amount of oil in the tract does not change depending on the winner, and is unknown until the land is drilled.

1.1.3 Bidding for Firms

So now, with that background, I will show you what I think the appropriate model is for the subsidy competition for large plants and headquarters in the United States. I use institutional details to inform my modeling approach.

First, we know that firms care about not only the subsidy offer, but also the location characteristics. So, it is as if there is a price and a quality component to the bid. We need a scoring auction. In other words, the auction is not a competition over subsidies, but a competition over location payoffs, where the payoffs are the sum of the subsidies and the location profits. The subsidies are just the lever that the state can control, it cannot instantaneously change the location characteristics.

Second, we know that there are multiple bids submitted for the same government. So, the state puts in one offer, hears back from the firm, and updates the subsidy package to make it more generous. This is an ascending auction.

Third, we know that states have some information on each others' offers. For example, North Carolina's internal reports for the Job Creation Investment Grant describes how many other states were considered for a project, and the details of those states' incentive packages. This is because the firm is letting North Carolina know when another state has a more attractive offer, giving North Carolina a chance to respond. This approximates the open outcry auction.

Lastly, we need to take a stand on the information structure. I think that the private values paradigm is appropriate: each state or city has a location-specific benefit of winning the firm. This can be private value conditional on observable firm characteristics, so all states can agree, for example, that more jobs are better. An alternative approach would be to model it as a common value auction. That assumption would mean that the firm creates the exact same amount of value in each location it could enter, and the only reason we observe different subsidy offers is because each city has different guesses of what that value would be.⁵

Taken together we have a private value open-outcry ascending scoring auction. The open-outcry ascending auction is known as the English auction and I will use that terminology. The English auction is now a common way to model markets with negotiated prices. Recent work on consumer loans and mortgage markets take this approach to model consumers shopping across banks for the

⁵Kim (2023), in another chapter of this volume, has an interesting extension which allows for spillovers between jurisdictions. The valuation for winning a firm is private to the state, but they capture some of the valuation even if the firm does not choose that state, but locates in the neighboring jurisdiction.

best contract offer (Allen, Clark and Houde, 2019; Cuesta and Sepúlveda, 2019). The consumer will sign the contract with the lowest cost bank, at the interest rate that leaves the second-lowest cost bank with zero profits. Basically, they pay the 2nd price, which is the outcome of the English auction. In a subsidy competition the firm is ‘shopping’ across locations for the highest payoff, where the payoff is the location-specific profit plus the subsidy offer. The firm can then use other locations’ offers to negotiate better subsidy deals.

The bargaining analogy is illuminating because it highlights other realms of inter-governmental competition and cooperation where the English auction may be useful. Certainly this is not only a tactic that is used by individual firms; trade associations, for example, may lobby local governments for preferential tax regimes or changes in regulations for a specific type or group of firms—using other states’ existing regulations as leverage.

2 Model, Identification, and Estimation

In this section I will formalize the model to set ideas and aid in the discussion of identification and estimation. This is a slightly simplified version of the model in Slattery (2022).

2.1 Model

There are two types of agents in the model: State Governments that compete with subsidies and Firms that receive discretionary subsidies. The timing of the game is as follows:

(t=0) *Firm i* decides to expand or relocate, and contacts a short list of n sites, $s \in \mathcal{N}_i$, about the locating in s .

(t=1) *State governments*, $s \in \mathcal{N}_i$, bid for firm i .

(t=2) *Firm i* locates in the site with highest payoff.

Each location $s \in \mathcal{N}_i$ independently draws a profit level and a private valuation for firm i , $\{\pi_{is}, v_{is}\}$, from the joint distribution $H_{\Pi, V}(\pi, v|z)$. The sum of profit and valuation, $w_{is} = \pi_{is} + v_{is}$, represents the total welfare created if firm i locates in location s .

Locations that are on the firms’ short list, \mathcal{N}_i , compete for the firm in a private valuation English auction. The English auction is an open outcry ascending auction, which means that a state can announce a bid and then increase their bid once another state makes a more attractive offer. The optimal strategy for states in the auction is to drop out of the bidding when the subsidy reaches their

valuation for winning the firm.⁶

The firm's objective is to maximize payoffs. This means that the winning state is not always the one with the highest subsidy offer. Instead the firm will locate in the state that gives them the highest payoff, which is the sum of their profit in the state and the subsidy offered by the state.

I model firm i 's payoff from locating in state s as the sum of subsidies and profits: $\text{subsidy}_{is} + \pi_{is}$. Here, subsidy_{is} is the final bid (subsidy offer) of state s , and π_{is} is the profit of firm i in state s . The profit can include the existing tax structure, local wages, regulations, and other location characteristics that the firm values.

Firm i locates in s if it gives the highest payoff of all states in S :

$$y_{is} = \mathbb{1}[\text{subsidy}_{is} + \pi_{is} \geq \text{subsidy}_{im} + \pi_{im} \quad \forall m \in S^n].$$

The outcome of the model is a set of equilibrium subsidies and firm locations, $\{\text{subsidy}_{is}^*, y_{is}^*\}$, such that:

$$\text{losing subsidy offers: } \text{subsidy}_{ij} = v_{ij}(x_j, z_i)$$

$$\text{winning subsidies: } \text{subsidy}_{is}^* \leq v_{is}(x_s, z_i)$$

$$\text{locations: } y_{is}^* = \mathbb{1}[\pi_{is} + \text{subsidy}_{is}^* \geq \pi_{ij} + \text{subsidy}_{ij} \quad \forall j \in S^n].$$

2.2 Auction Example

Consider the case where two states compete for a firm. State A values winning the firm at \$80 million dollars, and State B values winning the firm at \$100 million. However, the firm is more profitable in State A, where it would make \$50 million, instead of \$40 million in State B. Therefore, in absence of any competition, the firm would locate in state A. Total welfare sums state and firm payoffs to \$130 million.

The outcome changes when the states can compete with subsidies. State B could start off the bidding by making an offer to dominate State A, offering \$11 million and giving a total payoff of \$51 million to the firm. State A can respond when they learn they have been overbid, and so can State B.

⁶The English Auction is strategically equivalent to the sealed bid second price auction, i.e. the optimal strategy is to bid (or bid up to) your valuation. If you bid more than your valuation then you receive a negative payoff upon winning the auction. If you bid (or drop out) below your valuation, there is a chance that you will lose the auction at a price you would have been willing to pay.

The two states will go back and forth, making offers until one of the states arrives at their *stopping rule*. This occurs when State A offers a subsidy of \$80 million. They are not willing to go over \$80 million; this is how much they value the firm. So, the best offer State A can make to the firm is a payoff of \$130 million (\$80 million in subsidy plus \$50 million in profits).

State B then responds with a slightly more attractive offer: offering a subsidy of slightly more than \$90 million and leaving the firm with a payoff of \$130 million and change. Therefore, under subsidy competition, the firm makes a different location choice, choosing State B, and total welfare is \$140 million.

What is important here? We should compare these two outcomes. Without subsidy competition the firm's location choice results in a total welfare of \$130 million, with \$100 million going to State A and the \$30 million in going to the firm. Subsidy competition slightly increases the size of the pie, resulting in a total welfare of \$140 million. However, in the subsidy competition case State B captures less than \$10 million of the surplus, and the firm receives more than \$130 million. So, in the aggregate, state payoffs are higher without competition.

This example highlights the importance of the distribution of valuations and profits for policy analysis. If State B had a higher value for winning the firm, so a more negative correlation between valuation and profits, we could have aggregate state payoffs increase. If instead, State B had a smaller value for winning the firm, we would be in a zero sum game case, where the firm would still locate in State A with a subsidy, so we would just transfer rents from the state to the firm with no change in location choice. Here, the welfare results will depend on the distribution of these two objects, which we will be able to estimate with the help of the auctions framework.

2.3 Estimation and Identification

Estimation of the model depends on the data the researcher has available and the assumptions the researcher is willing to make. This of course will vary, and reasonable researchers often come to different conclusions on the correct assumptions—or the assumptions can depend on the institutional details in the setting. I will discuss two approaches to estimation of the model, given different sets of assumptions.

Suppose that researchers were to observe the realized subsidies in the places that the firm located, the runner-up location in the competition, and the number of bidders (or the number of states that

were in the running for the new plant or headquarters). This is what I observe in Slattery (2022). If firms did not care about differences in profitability across locations, and just chose the highest subsidy location, then data on winning bids and the number of bidders is sufficient to recover the distribution of valuations (Athey and Haile, 2002).⁷

However, we do think that firms do care about profits. That is why we specified this as a scoring auction. Given that it is a scoring auction, we need to recover the scoring rule (the firm’s profit function). To this end, I parameterize the firm profits and the government’s valuation function.

Assumption 1 *Profits of firm i in state s are a linear function of a set of observed location characteristics, x_s : $\pi_{ics} = x_s\beta$.*⁸

Assumption 2 *The valuation is a function of a set of observed location and firm characteristics, z_{is} , and an unobserved location-firm specific match, ϵ_{is} . The unobservable portion of the valuation is additively separable, mean zero, and independent of location observables that affect profits: $v_{is} = \alpha z_{is} + \epsilon_{is}$*

Given the model, and these basic assumptions over the parameterization of profits and valuations, we can proceed to the discussion of identification and estimation. I will discuss two approaches, each which require different assumptions.

2.3.1 Order Statistic Approach

The first approach starts with the outcome of the English auction, and proceeds in three steps.

Step 1. The model tells us that the winning location will offer a subsidy that makes the firm indifferent from locating in the winning or runner-up location. Therefore, the payoffs in the winning and runner-up locations should be roughly equivalent, where (1) denotes the winning location and (2) the runner-up:

$$\pi_i^{(1)} + \text{subsidy}_i^{(1)} = \pi_i^{(2)} + \text{subsidy}_i^{(2)}. \tag{1}$$

⁷The intuition here is that in the English auction the winning bid is equivalent to the valuation of the 2nd place bidder, because the 2nd place bidder would have bid all the way up to their valuation for the good. Therefore, winning bids represent the 2nd highest valuations, and this is an order statistic for the distribution of valuations, and if we know the number of bidders, we can recover the parent distribution.

⁸This is a simplification of Slattery (2022), where I specify profits as a random coefficients model, estimating β_i , where $\beta_i = \beta + z_i\beta^o + \sigma\eta_i$ and $\eta_i \stackrel{\text{iid}}{\sim} N(0, 1)$. The random coefficients model allows firms that are similar on observables to have different preferences over location characteristics, for reasons that are unobservable to the econometrician.

Any location that does not win the auction will end up bidding up to their valuation for winning the firm, which means that $\text{subsidy}_i^{(2)}$ is equivalent to the runner-up's valuation, and I can follow the parameterization specified above in Assumptions (1) and (2) to plug in for π and v and rearrange terms, giving a functional form for winning subsidies:

$$\text{subsidy}_i^{(1)} = (x^{(2)} - x^{(1)})\beta + z_i^{(2)}\alpha + \epsilon_i^{(2)}. \quad (2)$$

Therefore, profit parameters are identified with variation in the difference between the two characteristics, and winning bids. To see the intuition for this approach, imagine two subsidy deals for automobile manufacturing facilities of identical size. One plant locates in Alabama with a subsidy of \$100 million and the other locates in Ohio with a subsidy of \$140 million. In both cases, the runner-up in the subsidy competition is South Carolina, so the runner-up valuation and profit are held constant. Now suppose Alabama and Ohio have almost all of the same location characteristics: the same tax rate, the same wages, the same skilled workforce. The only difference between the two states is that Alabama is a right to work state and Ohio is not. Then, the \$40 million difference in the two observed subsidy deals can be attributed to how much automobile manufacturers prefer to locate in a right to work state.

Step 2. Given the estimates of $\hat{\beta}$ and $\hat{\alpha}$, as well as residual $\hat{\epsilon}$, I predict total welfare (payoffs) in the runner-up location. The estimates of welfare in the runner-up locations give way to the distribution of the second order statistic of welfare. The last assumption that I need to make before proceeding to the estimation is on the distribution of welfare:

Assumption 3 *Welfare across locations, w , is distributed i.i.d. $F(w|z)$.*

This assumption precludes bidder types—strong versus weak locations. It is a strong assumption, given the observed differences across bidders, and therefore I also propose an alternative estimation approach in the next subsection. I can nonparametrically identify the distribution $F(w|z)$, using the distribution of runner-up welfare, $F(w|z)^{(n-1:n)}$. Identification of $F(w|z)$ comes from the order statistic identity. The i -th order statistic from an i.i.d. sample of size n from an arbitrary distribution

F has distribution (Arnold, Balakrishnan and Nagaraja, 1992; Athey and Haile, 2002):

$$F^{(i:n)}(w|z) = \frac{n!}{(n-i)!(i-1)!} \int_0^{F(w|z)} t^{i-1}(1-t)^{n-i} dt \quad (3)$$

where n is the number of bidders. Therefore the distribution of welfare in all states, $F(w|z)$, is identified from data on the 2nd order statistic of welfare, $w_i^{(n-1:n)}$.

Step 3. Finally, I invert this welfare distribution to recover the marginal distribution of state valuations. I have this representation of welfare being the sum of the valuation of the state, and the profit of the firm. I know the distribution profit of the firm from step 1, and the distribution of welfare from Step 2, so I can back out the distribution of valuations.

2.3.2 Extreme Value Approach

Given the same model, an alternative approach relies on an assumption on the error term, ϵ .

Assumption 4 *The unobservable state valuation, ϵ is, independently distributed according to an extreme-value distribution with location and scale parameters $(0, \sigma_\epsilon)$.*⁹

Given this assumption, welfare also has an extreme-value distribution with location and scale parameters $(x\beta + z\alpha, \sigma_\epsilon)$. Therefore, I can write the probability of observing the winning location, $y_i^{(1)}$, among the set of locations considered, \mathcal{N}_i , with the usual logit formula:

$$P(y_i^{(1)}|\mathcal{N}_i) = \frac{\exp\left(\frac{x_i^{(1)}\beta + z_i^{(1)}\alpha}{\sigma_\epsilon}\right)}{\sum_{k \in \mathcal{N}_i} \exp\left(\frac{x_k\beta + z_k\alpha}{\sigma_\epsilon}\right)} \quad (4)$$

Given the set of locations on the short-list, \mathcal{N}_i , this is a standard logit that I can estimate to recover β/σ_ϵ and α/σ_ϵ with variation in the characteristics of the winning and non-winning locations (Fox, il Kim, Ryan and Bajari, 2012).¹⁰ This is similar to the approach that Brühlhart, Jametti and Schmidheiny (2012) take to study the effect of agglomeration and tax differentials on firm locations.

However, I only observe the choice set, \mathcal{N}_i , for half of the sample. This is the second assumption needed for this approach. I simulate potential short list locations, using observables. Therefore, I can

⁹This is a common approach to modeling auctions with asymmetric value distributions (Allen, Clark and Houde, 2019; Brannman and Froeb, 2000).

¹⁰I also have another piece of information—the second choice locations (the runner-ups). Therefore, I can instead maximize the probability I observe the winning ($y_i^{(1)}$) and runner-up ($y_i^{(2)}$) location out of the set of potential locations \mathcal{N}_i . This follows the same logic as Equation 4 but provides more variation for identifying β and α .

proceed by simulated maximum likelihood to estimate $\hat{\beta}$ and $\hat{\alpha}$. Given, $\hat{\beta}$ and $\hat{\alpha}$ I can predict profits and the observable portion of valuation in each location. However, we also have the unobservable part of the valuation, ϵ_{is} , which will dictate the added heterogeneity in state valuations, and therefore the welfare results.

I identify σ_ϵ using data on winning bids and the outcome from the model that I use in the previous approach. Therefore, given $\hat{\beta}, \hat{\alpha}$, and simulations of ϵ_i , I can use Equation 2 to predict subsidies. The only remaining unknown, σ_ϵ , is pinned down by matching the distribution of model predicted subsidies to observed subsidies (data).

2.4 Counterfactual Analysis

Given that we finally have our main objects of interest, the distributions of state valuations and profits, we can move to the counterfactual analysis. I want to discuss three counterfactuals that would be feasible given the estimation model and estimation I detail above. Then, in the next section, I will discuss more ambitious models and the associated counterfactuals.

The first, which is what I do in Slattery (2022), is a subsidy ban that restricts states and local governments from offering discretionary subsidies or any tax credits. This is a partial equilibrium analysis, because I do not have states also choosing tax rates in the model, so I cannot to allow the states to change their tax rate, which we might think would happen if we restricted incentives. In order to implement this counterfactual, I predict where each firm would be most profitable, using the estimated profit parameters. Given that profit, I simulate the valuation of the winning location, from the joint distribution. Then I compare the total welfare with and without subsidy competition.

Another interesting, and potentially more realistic counterfactual would be a regional truce. In this case, a subset of regions, perhaps neighbors, agree not to compete for firms. Using the same technique as the total ban, one could predict the resulting firm locations, welfare, and interestingly, how the distribution of winning subsidies would change under the new regime.

Lastly, as a complement to the subsidy game, we can use the estimates from the model to study the effect of investments in location characteristics, as opposed to changes in subsidy regimes. For example, if a state invested in infrastructure, one could estimate how this would change the number of firms the state attracted and the equilibrium subsidy offers needed to attract them.

3 Closing Thoughts

If bidding for firms is bad, what should be done to limit it? Although there is a long history of subsidy-giving in the U.S., evaluating subsidy competition has been difficult due to limited data and a lack of exogenous variation in the policy space. Auctions provide a convenient framework, allowing researchers to learn about the primitives of interest even with limited amounts of data. Importantly, the auction is necessary for the policy counterfactuals—how do different restrictions on bidding affect firm locations and other economic outcomes of interest?

Interested researchers can do even more with the auction framework. For example, if you are interested in the dynamic interaction between subsidy contests, a sequential auction would allow you to factor in the fact that some states do have a binding budget constraint or that their willingness to pay may be affected by past performance. Another idea that I am excited about is incorporating entry. In past work I find that subsidy competition does not do much to improve allocative efficiency because the locations that would benefit the most from winning a subsidy contest are never even considered as a potential location (Slattery, 2022). One could incorporate the entry decision of the states and regions to engage in the competition, which would allow a counterfactual where there are some sort of matching subsidies or preferences for disadvantaged regions, just as government procurement auctions have programs that prefer disadvantaged bidders.

This is not a U.S. specific phenomenon. This paper is framed around a competition between states, but one can think of competition between countries, or, at an even more local level, competition between municipalities within a state or region. It happens, with more regulations, in the European Union, and is quite common in other large countries like Canada, Brazil and India. There is much more to learn about competition and economic development policy in these contexts. I am optimistic that future work can continue to leverage the auction and other models used in empirical Industrial Organization to study competition between governments and the potential policy responses to limit that competition when it is harmful.

References

Allen, Jason, Robert Clark, and Jean-François Houde. 2019. “Search Frictions and Market Power in Negotiated-Price Markets.” *Journal of Political Economy*, 127(4): 1550–1598.

- Arnold, Barry, N. Balakrishnan, and H. N. Nagaraja.** 1992. *A First Course in Order Statistics*. SIAM.
- Athey, Susan, and Philip Haile.** 2002. “Identification of Standard Auction Models.” *Econometrica*, 70(6): 2107–2140.
- Black, Dan A, and William H Hoyt.** 1989. “Bidding for Firms.” *The American Economic Review*, 79(5): 1249.
- Brannman, Lance, and Luke M. Froeb.** 2000. “Mergers, Cartels, Set-Asides, and Bidding Preferences in Asymmetric Oral Auctions.” *The Review of Economics and Statistics*, 82(2): 283–290.
- Brühlhart, Marius, Mario Jametti, and Kurt Schmidheiny.** 2012. “Do Agglomeration Economies Reduce the Sensitivity of Firm Location to Tax Differentials?” *The Economic Journal*, 122(563): 1069–1093.
- Cuesta, José Ignacio, and Alberto Sepúlveda.** 2019. “Price Regulation in Credit Markets: A Trade-off between Consumer Protection and Credit Access.” Working Paper.
- Fox, Jeremy T., Kyoo il Kim, Stephen P. Ryan, and Patrick Bajari.** 2012. “The random coefficients logit model is identified.” *Journal of Econometrics*, 166(2): 204–212.
- Hortaçsu, Ali, and Isabelle Perrigne.** 2021. “Chapter 11 - Empirical perspectives on auctions.” In *Handbook of Industrial Organization, Volume 5.*, ed. Kate Ho, Ali Hortaçsu and Alessandro Lizzeri, 81–175. Elsevier.
- Kim, Donghyuk.** 2020. “Government Incentives and Firm Location Choices.” Working Paper.
- Kim, Donghyuk.** 2023. “Inter-jurisdictional Competition and Coordination: Evidence from Kansas City.” In *Policy Responses to Tax Competition*. NBER.
- Martin, Laurent.** 2000. “Bidding for firms: An asymmetric auction model of interjurisdictional competition.” University of Washington Working Paper.
- Mast, Evan.** 2020. “Race to the Bottom? Local Tax Break Competition and Business Location.” *American Economic Journal: Applied Economics*, 12(1): 288–317.
- Ossa, Ralph.** 2018. “A Quantitative Analysis of Subsidy Competition in the U.S.” National Bureau of Economic Research Working Paper 20975.
- Slattery, Cailin.** 2022. “Bidding for Firms: Subsidy Competition in the U.S.” Working Paper.