Government Incentives and Firm Location Choices

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Abstract

State governments in the United States have been increasingly using business incentives such as grants and tax abatements to compete for firms. I examine the welfare consequences of this competition. I develop a model of state government competition and firm location choice combining a first-price auction among states with discrete choice by firms. I estimate this model using firm-level data on accepted incentives augmented with data on state attributes. To learn about state valuations for attracting firms and firms' geographic preferences, I exploit the first-order conditions for states' optimal bidding strategies and variation in firms' accepted offers and locations. I find that competition improves the overall welfare of states and firms despite the deadweight loss of taxation incurred by incentive provision. Firms benefit substantially by capturing rents from states. States that are less profitable for firms without incentives tend to have higher valuations for firms and benefit from competition. When taking into account the deadweight loss of taxation, states as a whole gain only modestly, as firm location choices are relatively unresponsive to incentives and the heterogeneity in state valuations is competed away. My findings are consistent with the view that state government competition using incentives generates large corporate welfare and little allocative efficiency when considering the deadweight loss of taxation, but does not fit the view that competition lowers overall welfare.

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1 Introduction

State governments in the United States have been increasingly using business incentives such as grants and tax abatements to compete for firms. The total amount of incentives paid to firms more than tripled since the 1990s, reaching $45 billion in 2015.[1] As a result, the debate on whether state governments should use incentives to compete for firms has received much public attention. Recent competition among governments to attract Amazon's second headquarter with incentives has further intensified this debate. Despite growing public interest, our understanding of the welfare consequences of state government competition using incentives is limited.[2] Does competition improve the overall welfare of states and firms? How are the welfare impacts distributed across different states and firms?

I approach these questions by using data on accepted incentives and state attributes to quantify states' valuations for attracting firms and firms' geographic preferences. I provide empirical evidence that competition improves the overall welfare of states and firms despite the deadweight loss of taxation incurred by incentive provision. I find that firms capture substantial rents from states. States that are less profitable for firms without incentives tend to have higher valuations for firms and benefit from competition. When taking into account the deadweight loss of taxation, states as a whole gain only modestly, as firm location choices are relatively unresponsive to incentives and the heterogeneity in state valuations is competed away. My findings are consistent with the view that state government competition using incentives generates large corporate welfare and little allocative efficiency when considering the deadweight loss of taxation, but does not fit the view that competition reduces overall welfare.

To build intuition for how state valuations for firms and firm preferences shape welfare consequences of competition, consider a firm choosing between California and Nevada. Suppose California is more profitable for the firm without incentive offers (no state competition). If California's valuation for the firm is higher than Nevada's, the firm's location choice would be efficient without competition. If the firm's choice is unresponsive to incentives or if Nevada's valuation for the firm and equilibrium incentive offer are not sufficiently high, the firm would choose California regardless of whether states compete. In such cases, competition would reduce welfare since incentives paid by California incur deadweight loss of taxation; states would face a prisoner's dilemma, and welfare would improve if states could commit not to offer incentives. On the other hand, if Nevada's valuation and equilibrium incentive offer are sufficiently high, the firm would choose Nevada. In this case, the firm and Nevada would gain from competition while California would lose. States as a whole would be better off if California's valuation is lower than Nevada's valuation net of incentives

[1] This estimate includes incentives provided by both state and local governments (Bartik (2017)). Other existing estimates include $80.4 billion (Story et al. (2012)) and $65 billion Thomas (2010)). A wide range of estimates exists mainly because incentive information is not always made public.

[2] Existing empirical work related to this question include a recent work by Slattery (2018) and studies of local competition using incentives (e.g., Mast (2018)), individual place-based policies (e.g., Busso et al. (2013), Neumark and Kolko (2010)), and state taxes (e.g., Suárez Serrato and Zidar (2016), Fajgelbaum et al. (2015), Moretti and Wilson (2017)).

and the deadweight loss of taxation. In other words, competition would improve welfare despite the deadweight loss of taxation if Nevada's valuation for the firm is sufficiently high and the firm chooses Nevada when states compete.[3]

To learn about state valuations and firm preferences, I use firm-level data on accepted incentives from the Good Jobs First Subsidy Tracker combined with data on state attributes that likely determine state valuations and firm preferences. Incentive data contains information on accepted incentive amount, awarding state, and firm attributes such as size and sector. I begin by gathering suggestive evidence on how states and firms value each other. Descriptive regression results suggest that states value firm attributes that likely deliver greater local benefits (manufacturing jobs) and that states with weaker economic conditions and more Republican voters have higher valuations for firms. Firms, on the other hand, appear to take into account local costs and workforce accessibility and quality. These suggestive findings are mostly consistent with a recent work by Bartik (2017). Challenged by the lack of data on unaccepted incentive offers, I am unable to further learn from this exercise about the actual trade-offs that firms faced in choosing locations and the distribution of states' latent valuations for firms. This motivates me to develop a structural model to interpret the accepted incentive data which are an outcome of a strategic interaction among state governments and firm choice.

I develop a model of state government competition and firm location choice that combines a first-price auction among states with discrete choice by firms. State governments draw private valuations for firms and simultaneously offer incentives to firms. Upon receiving incentive offers, each firm draws latent profit shocks and chooses the state that delivers the maximum total profit, which depends on incentive offers, state attributes, and the profit shocks.[4] While this model resembles a first-price scoring auction, there are two key distinguishing features.[5] First, firm profit function parameters are unknown to the econometrician, whereas auction scores are typically known in scoring auctions. Second, unlike most auctions, the state with the highest sum of bid and deterministic profit (highest auction score) does not necessarily win due to the presence of random profit shocks for each state attribute and each firm-state combination, similar to attribute-specific and product-specific taste shocks commonly used in discrete choice models. These shocks are unobserved by both states and the econometrician. Using a numerical example, I illustrate that the welfare gain from competition increases with firms' sensitivity to incentives and the heterogeneity in state valuations when firm profits and state valuations are negatively correlated. Model primitives are state valuation distributions and the profit function parameters.

To learn about state valuations and firm preferences using data on accepted incentives and state attributes, I exploit the first-order conditions for states' optimal offers and variation in conditional distributions of accepted incentives. The first-order conditions from the government competition

[3]Competition may improve overall welfare even though the states as a whole are worse off. This can happen if Nevada offers large incentives and the firm's gain more than makes up for the loss in states' welfare.

[4]Mast (2018) does not allow governments to have private and random valuations for firms, resulting in deterministic incentive decisions.

[5]My model falls under a class of multi-attribute auctions which is little studied. See Krasnokutskaya et al. (2017) for a recent study of this class of models with an application to an online procurement market.

model provide a way of inferring state valuations for firms from observations on incentives accepted by firms. This strategy is commonly used in empirical studies of first-price auctions following Guerre et al. (2000). Variation in accepted incentive distributions conditional on observable determinants of state valuations (e.g., firm size, state's economic and political conditions) is informative of how firm profitabilities vary across states. Intuitively, states that are less profitable for firms would, on average, bid more aggressively, but would also win only with particular high bids. Variation in firms' headquarter locations, which are likely exogenous to state valuations, further allows me to exploit within-state variation in accepted incentives conditional on firm attributes determining state valuations.

I use the method of simulated moments to estimate model parameters. For most states, estimated parameters of the firm profit function imply a relatively low bid elasticity of less than one for a representative firm. Firms prefer states with higher population, higher college attainment rates, and lower wages. The implied dollar values of the location characteristics are fairly large. State valuations for firms exhibit substantial heterogeneity; for the same representative firm, the difference in average valuations ranges up to a million dollars. Average state valuations and firm profitabilities are negatively correlated (i.e. states with high valuations for firms tend to have low deterministic profitabilities for firms). Further, political leanings of states are strong predictors of state valuations, suggesting that political factors have large impacts on how states formulate their valuations for firms. Overall, a large heterogeneity in state valuations and a negative correlation between firm profits and state valuations imply that state government competition is more likely to improve welfare, while firms' unresponsiveness to incentives implies the opposite.

Using estimated parameters, I consider a counterfactual elimination of state government competition in which firms choose states without incentives. I find that competition improves the overall welfare of states and firms by 9% despite the deadweight loss of taxation incurred by incentive provision. Roughly 70% of firms choose the same states regardless of whether competition is in place, and 17% of incentives are spent on such immobile firms. Firm profits increase by 11% from extracting state valuations. States that are less profitable for firms without incentives tend to have higher valuations for firms and benefit from competition. When taking into account the deadweight loss of taxation, states as a whole gain modestly by less than one percent, as a result of relative unresponsiveness of firm choices to incentives and the heterogeneity in state valuations being competed away. This finding is consistent with the view that state government competition using incentives generates large corporate welfare and little allocative efficiency when considering the deadweight loss of taxation, but does not fit the view that competition reduces overall welfare.

The rest of this paper proceeds as follows. Remainder of this section discusses related literature. Section 2 outlines the context of state government competition using incentives and describes the dataset used in this paper. Section 3 provides suggestive evidence on how states and firms value each other. Section 4 presents the model of state government competition and firm location choice, and Section 5 provides intuition for model identification. Section 6 describes the estimation procedure. Section 7 presents the estimation results, and Section 8 analyzes the welfare implications of state government competition. Section 9 concludes.

Related literature

Most closely related to this paper are Mast (2018) and Slattery (2018). My model of state government competition as a first-price auction is similar to the one used by Mast (2018) studying local competition among towns in New York state, but I further allow state governments to have private and random valuations for firms to account for the variation in accepted incentives conditional on state and firm characteristics.[6][7] While I find, similar to Mast (2018), that firms choices are relatively unresponsive to incentives, I focus on state competition using a broader category of incentives and discuss how government valuations for firms and firm preferences shape welfare implications of competition. Related literature on assessing individual place-based policies includes Busso et al. (2013), Greenstone et al. (2010), Kline and Moretti (2014), Neumark and Kolko (2010), and Jensen (2017). I take a different approach of estimating local values of attracting firms by not focusing on specific local outcomes or mechanisms (e.g., agglomeration) but using incentive data to infer states' latent valuations for firms. I also provide empirical evidence of how place-based policies may generate only a modest welfare gain for the states as a whole if considering the strategic aspect of how such policies are designed. Using a different methodology, Ossa (2015) studies the subsidy competition among states in a trade framework with agglomeration externalities and calibrates it with aggregate data. Bartik (2017) documents the overall trend in incentive provision using a newly constructed database.

Theoretical work on government competition using firm-specific subsidies includes Black and Hoyt (1989), Garcia-Mila et al. (2002), Glaeser (2001). I address the normative question raised in Glaeser (2001) regarding social desirability of government competition using incentives. Related literature on fiscal federalism dates back to Tiebout (1956) and is reviewed by Oates (1999) and Wilson (1999).

More broadly, empirical work on firm mobility is expansive and places emphasis on the role of state taxes or other statewide policies such as right-to-work laws and their welfare consequences (e.g., Suárez Serrato and Zidar (2016), Fajgelbaum et al. (2015), Moretti and Wilson (2017), Giroud and Rauh (2015), Holmes (1998), Bartik (1985)). Another strand of literature focuses on how the cost and network structure of firms impact their location decisions (e.g., Rosenbaum (2013), Holmes (2005), and Henderson and Ono (2008)). My study differs in both topic and methodology from some of these studies using spatial equilibrium framework. I focus on firm-specific incentives rather than state taxes and directly model state government competition and firm location choice, drawing on methodologies from the Industrial Organization literature. Despite these differences, I find, similar to Suárez Serrato and Zidar (2016), that firms are substantially immobile due to the differences in the local productivities.

[6] Mast (2018) uses variation in firms' preferred locations, calibrated outside the model, to account for variation in accepted property tax breaks conditional on observables.

[7] Slattery (2018) models state government competition using an oral ascending auction and also separately models indirect job creation of firms.

I use methods building on the empirical auction (Guerre et al. (2000)) and discrete choice (Berry (1994)) literature. This paper's model is similar to the one used by Krasnokutskaya et al. (2017) who study online procurement markets and provide identification and estimation strategies. Large number of potential bidders and possible combinations characterize the main econometric challenge in their study whereas the lack of information on losing bids (unaccepted incentives) is the main difficulty in this paper.

2 Context and data

State and local economic development agencies of various names (e.g., Department of Economic and Community Development in CT, Economic Development Administration in New Haven, CT) are government agencies whose general mission is to advance the economies of the respective jurisdictions. Inevitably, attracting and retaining businesses is one of the stated objectives of these agencies, and incentive provision to firms has been increasingly used to fulfill that goal. Estimates of how much state and local governments spend on incentives each year range from \$45 to \$80.4 billion (Bartik (2017), Story et al. (2012)).

Many different types of incentives exist, and the details of incentive contracts are often reached through interactions with individual firms. Prevalent types of incentives include tax credits, grants, cost reimbursement, job training, and infrastructure assistance. Incentive contracts also specify the timing of payments (front vs. back-loading) and may include clawback provisions to ensure that firms fulfill employment and investment requirements. Bartik (2017) discusses in detail various types and terms of incentives. Firms that receive incentives also vary widely in sizes and industries, ranging from local restaurants looking to relocate to multinational corporations looking to construct manufacturing plants. The level of government competition changes with firm characteristics as well; small businesses are likely to search over a preferred local area and prompt a government competition at the local level, while large companies are likely to conduct a national search and scale up the government competition to the state level.

The specifics of how governments compete and negotiate with firms over incentives vary, but firms typically conduct preliminary surveys of available locations and produce shortlists of candidate locations.[8] In private meetings with government representatives, firms will illustrate the benefits that they can bring to regions, while government representatives will highlight the strengths of their locations and offer incentive packages. Firms may address specific needs regarding properties, infrastructure, and workforce, which may be reflected in incentive contracts. Governments will also try to ensure that firms fulfill their promises by backloading payments or including clawback provisions. Search and negotiation costs are likely to hinder small firms from considering locations that are distant from one another, and firms are also known to commonly employ consultants to act on their behalf.

[8] LeRoy (2005) describes a typical site selection process. Individual firm cases are occasionally reported by the Site Selection magazine (e.g., `https://siteselection.com/ssinsider/bbdeal/bd060316.htm`)

As much of the interaction between governments and firms happens behind closed doors, public information on incentives is mostly limited to incentives that firms accept. The lack of information on unaccepted incentives presents a major challenge in studying government competition using firm-specific incentives. Furthermore, data on accepted incentives that are individually published by state and local economic development agencies are often less than ideal, only covering incentives provided under selected programs, lacking key details like firm characteristics, and in formats that are not readily usable. Numerous organizations have aggregated publicly available data, reinforcing them with information directly provided by governments upon individual requests.

This paper uses a dataset named Good Jobs First Subsidy Tracker, made available by Good Jobs First, an advocacy research organization. This dataset is publicly available and comprehensive, tracking incentives provided by federal, state, and local governments to firms from 1976 to present, along with information on firm characteristics.[9] Details on sample selection are provided in the appendix. Key variables of interest for this paper include the incentive amount, awarding state, year, number of jobs, and sector. Summary statistics of these key variables are shown in Panel A of Table 1. The large variance in the amount of incentive awarded per job suggests that incentive bids vary widely both across and within states. Figure 1 plots densities of incentives provided by selected states conditional on firm characteristics. The substantial across state variation shown in this figure may be explained by heterogeneities in states' profitabilities for firms and states' valuations for firms. This paper aims to quantify these heterogeneities. Further, substantial within-state variation in accepted incentives hint at the importance of unobserved firm attributes in determining states' incentive bids. My model accounts for this by allowing state valuations to be random conditional on observable determinants of state valuations (e.g., firm size). Although rich information on different types of incentives (e.g., property tax abatement) is also available in the dataset, I only use information on incentive benefits converted to dollar amounts, since it is difficult to compare the various terms of incentives offered by individual agencies. Figure 2 shows that 80% of incentives are awarded in the form of tax reduction and grants.

I augment the incentive dataset with separately collected data on state characteristics that are likely to impact states' incentive bidding behaviors through affecting either state valuations for firms or firm profitabilities. Whether and how these characteristics enter government and firm preferences are discussed in the next section, providing basis for the structural model that I develop. Summary statistics of these variables are shown in Panel B of Table 1, and data sources are provided in the appendix.

3 Suggestive evidence on how states and firms value each other

Because the dataset has no information on unaccepted incentive offers, it is difficult to learn directly about firms' geographic preferences nor states' latent valuations for firms. Nonetheless, accepted incentive data can still provide useful insights on how states and firms value each other based on

[9] I combine all incentives provided at the local level to the state level.

the argument that states' bidding behaviors are affected by states' valuations for attracting firms and firms' profitabilities in states. A state with high valuations for attracting firms, perhaps due to high unemployment rate, is likely to bid more aggressively and end up paying higher incentives for its accepted offers, than another state of comparable firm profitability. On the other hand, a state that firms find very attractive, perhaps due to high quality of the labor force, can likely afford to bid less aggressively and end up paying lower incentives for its accepted offers, than another state sharing comparable valuations for firms. In the former case, comparing accepted incentives made by states that are observationally equivalent in terms of the determinants of firm profitability provide evidence on the extent to which state valuations differ. In the latter case, comparing accepted incentives made by states that are observationally equivalent in terms of the determinants of state valuations provide evidence on the extent to which firm profitabilities differ. Based on this idea, preliminary evidence on how states and firms value each other is presented using the following regression specification:

$$b_{jst} = \alpha^v v_{jst} + \alpha^\pi \pi_{jst} + \epsilon_{jst}, \tag{1}$$

where b_{jst} denotes the incentive offered by state s and accepted by firm j in year t, v_{jst} denotes the determinants of state s's valuation for firm j, and π_{jst} denotes the determinants of firm j's profitability in state s.[10]

Proposed v_{jst} variables include firm characteristics that likely impact state valuations for firms: the number of jobs and a manufacturing dummy. State economic and political conditions that likely impact state valuations are also included as v_{jst} variables: unemployment rate, per capita income, and the percentage difference of Democratic and Republican votes in gubernatorial elections. These variables capture the likely sources of heterogeneity in state valuations. The political variable, in particular, highlights the fact that state valuations may not only reflect projected economic benefits but also state residents' willingness to spend public funds for incentive provision.[11]

Proposed π_{jst} variables include state characteristics that likely affect firms' profitabilities: wage, rent, college attainment rate, size (population and number of Metropolitan Statistical Areas (MSA)), corporate income tax rate, transportation infrastructure (highways, airports, and seaports), and the right-to-work law status.[12] Distance from firm's headquarter location is also added as a π_{jst} variable to account for geographic attractiveness of states. Vast survey evidence suggests that proposed π_{jst} variables influence firms' site selection decisions.[13]

Table 2 shows the regression results for selected specifications. Overall, proposed v_{jst} and π_{jst}

[10]I assume that v_{jst} and π_{jst} do not overlap. Otherwise, it would be impossible to learn about the directions in which such overlapping variables affect state valuations and firm profits.

[11]Jensen and Malesky (2018) find in a survey experiment that independent voters are more likely to support governors who offer more generous incentives to firms regardless of whether they are accepted.

[12]One rationale for including the state size variable is that firms likely have higher probabilities of finding a profitable location in a state that has more and bigger labor markets.

[13]Site Selection (2016) list taxes, incentives, infrastructure, regulatory environment, quality education system, and workforce as the most cited answers when consultants were surveyed about the top two or three elements of "state business climate." These characteristics are also incorporated into widely used state business climate indices published by various media outlets (e.g., CNBC). Amazon HQ2's Request for Proposal also lists similar characteristics as "key preferences and decision drivers."

variables carry anticipated signs, suggesting that they impact state valuations and firm profits in plausible directions. As for state valuations, firms that promised to bring more jobs were awarded higher incentives; manufacturers were also awarded higher incentives likely because they have higher local multipliers. States with higher unemployment rates that likely have higher valuations for new jobs provided higher incentives, while states with higher percentage of Democratic votes in gubernatorial elections provided lower incentives. As for firm profits, college attainment rate and number of MSA carry negative signs while rent and distance from headquarter carry positive signs.[14]

These findings are mostly in agreement with the results of an extensive descriptive analysis by Bartik (2017) using a different database. For example, he also finds that higher incentives are awarded to firms that pledged to bring greater local benefits, in particular to larger firms and manufacturers, and that states with higher gross taxes and lower per capita income tend to pay more incentives.[15] Bartik (2017) further notes that a substantial part of state variation in incentives appears to to be derived from different political leanings, which is confirmed by my findings.

4 Model

In this section, I present a model of state government competition and firm location choice using features of first-price auction and discrete choice models. Firms are denoted by $j \in \mathcal{J} := \{1 \cdots J\}$ and state governments are denoted by $s \in \mathcal{S} := \{1 \cdots S\}$.

4.1 Setup and timing

State government s derives private value from attracting firm j to its own jurisdiction according to an independent draw, v_{js}, from a valuation distribution denoted by $F_V(\cdot|x^v_{js})$ with bounded support $[\underline{v}, \overline{v}_s]$, where x^v_{js} denotes the observable determinants of state valuations.[16] Based on suggestive evidence from the earlier section, x^v_{js} includes firm size and sector and state economic and political variables. Each state government s then makes an optimal incentive offer b_{js} to each firm j.

Firm j chooses a state $s \in \{1 \cdots S\}$ that maximizes j's total profit. Firm j's profit from choosing state s is

$$\pi_{js} = \sum_{k=1}^{K} (\beta^{x0}_k + \beta^{x1}_k \zeta_{jk}) x^{\pi}_{sk} + \beta^b b_{js} + \beta^d d_{js} + \xi_s + \epsilon_{js}, \tag{2}$$

where x^{π}_s is a $K \times 1$ vector of exogenous characteristics of s (e.g., college attainment rate), b_{js} is s's incentive offer to j, d_{js} is the distance from j's headquarter to s, and ξ_s is unobserved

[14]Coefficients on right-to-work laws and corporate income tax rates are insignificant likely because they are strongly correlated with other variables included. I find that substituting unemployment rate with income, rent with wage, and number of MSA with population produce similar results.

[15]Nonetheless, Bartik (2017) emphasizes that incentives “do not vary as much as they should with industry characteristics that predict greater local benefits.”

[16]This approach of modeling state valuations for firms does not restrict firm presence to affect state valuations according to a particular mechanism. One downside of my approach, however, is that it is difficult to discern mechanisms generating state valuations.

characteristic of s common across firms. $\zeta_j = (\zeta_{j1}, \cdots, \zeta_{jK})$, which are drawn iid from standard normal distribution, represent firm's unobserved tastes for state attributes. $\epsilon_j = (\epsilon_{j1}, \cdots, \epsilon_{jS})$, which are drawn iid from Type I Extreme Value distribution, represent random profit shocks. Deterministic attributes of j's profit in s is denoted by $\chi^{\pi}_{js} = (x^{\pi}_s, d_{js}, \xi_s)$.

Given this setup, firm j's site selection process proceeds in two stages.

1. **Government competition**: Each state government s independently draws its private valuation for j, v_{js}, from $F_V(\cdot|x^v_{js})$. States are aware that all states are competing and know each other's valuation distribution but not the realized values. States also know $\theta^{\pi} = (\beta^x, \beta^b, \beta^d, \xi)$ but not ζ_j nor idiosyncratic shocks ϵ_j. States then simultaneously bid incentives to j.

2. **Firm decision**: Firm j receives a vector of incentive offers, $(b_{j1}, \cdots, b_{jS})$ and selects the state that maximizes its total profit.

4.2 Equilibrium incentive bids

State government s offers b that maximizes its expected value of attracting firm j given its valuation draw, v, by solving

$$\max_b \ (v - b) \cdot w_{js}(b), \tag{3}$$

where $w_{js}(b) : [\underline{b}, \overline{b}_s] \to [0, 1]$ denotes the probability of j accepting b from s.

The first-order condition for s's optimal bid b is then given by

$$b = v - \frac{w_{js}(b)}{w'_{js}(b)}, \tag{4}$$

where the second term on the right-hand side represents s's strategic markdown from its valuation for j.

The equilibrium bidding strategy of s is denoted by $m_s : [\underline{v}, \overline{v}_s] \to [\underline{b}, \overline{b}_s]$, which maps valuations into optimal incentive bids.[17] I focus on type-symmetric equilibrium in which states use symmetric bidding strategies conditional on having same valuation distributions and firm profitability attributes (i.e. same x^v_{js} and $\chi^{\pi}_{js} = (x^{\pi}_s, d_{js}, \xi_s)$). The equilibrium bid distribution of s is denoted by $G_B(\cdot|x^v_{js}, \chi^{\pi}_{js})$.

$w_{js}(b)$ can now be derived by integrating over all possible equilibrium bids of opponent states, b_{-s}, and firm j's unobserved tastes for state attributes, ζ_j, as

$$w_{js}(b) = \int_{\mathcal{B}_{-s}} \int_{\mathcal{R}^K} \gamma_{js}(b, b_{-s}, \zeta_j) d\Phi_{\zeta}(\zeta_j) dG_{B_{-s}}(b_{-s}), \tag{5}$$

[17]Theoretical advancements formally showing equilibrium existence and properties in this variant of first-price auction model are needed, but outside the scope of this paper.

where

$$\gamma_{js}(b, b_{-s}, \zeta_j) = \frac{\exp\left(\sum_{k=1}^{K}(\beta_k^{x0} + \beta_k^{x1}\zeta_{jk})x_{sk}^{\pi} + \beta^b b_{js} + \beta^d d_{js} + \xi_s\right)}{\sum_{\hat{s}\in\mathcal{S}} \exp\left(\sum_{k=1}^{K}(\beta_k^{x0} + \beta_k^{x1}\zeta_{jk})x_{\hat{s}k}^{\pi} + \beta^b b_{j\hat{s}} + \beta^d d_{j\hat{s}} + \xi_{\hat{s}}\right)}.$$

Above, $\mathcal{B}_{-s}$ is the possible region of opponent bids, and $\gamma_{js}(b, b_{-s}, \zeta)$ is the probability of j accepting b from s when offers from other states are equal to b_{-s} and j's unobserved tastes for state attributes are equal to ζ_j. $d\Phi_\phi$ is the known joint density function of ζ, and $dG_{B_{-s}}$ is the joint density function of equilibrium bids of opponent states.

Primitives of this model are firm profit function parameters, $\theta^\pi = (\beta^x, \beta^b, \beta^d, \xi)$, and state valuation distributions, $F_V(\cdot|\cdot)$.

4.3 Relation to first-price auction and discrete choice models

The proposed model of state government competition resembles a first-price scoring auction with independent asymmetric values, while the proposed model of firm location choice resembles a standard discrete choice model. Despite similarities, this paper's competition model differs from a first-price scoring auction in two important ways. First, firm profit function parameters, $\theta^\pi = (\beta^x, \beta^b, \beta^d, \xi)$, are unknown to the econometrician, and part of this paper's objective is to learn about these parameters which govern firms' trade-offs between incentives and other state attributes. These parameters would be analogous to auction score weights in scoring auction models which are typically known to the econometrician (e.g., weights on cost and time in highway procurement auctions).[18] Second, in my model, competition outcome is partly determined by firms' unobserved tastes for state attributes (ζ) and random profit shocks (ϵ) which are unobserved by both states and the econometrician. In terms of standard auctions, these shocks can be interpreted as auctioneers' (firms') unobserved preferences over bidders (states) and their characteristics. This approach of incorporating unobserved preference heterogeneity is commonly adopted in discrete choice models. One consequence of having this feature in my model is that even if state s were to possess the highest $\beta^{x0}x_s + \beta^b b_{js} + \beta^d d_{js} + \xi_s$ (analogous to highest auction score), it may not win if firm j draws a sufficiently low ϵ_{js} or ζ_j that is unfavorable for s's attributes. Standard scoring auctions do not feature such stochastic allocation rules. These departures from standard auction models prevent direct application of existing results in the auction literature, but this model may be used to describe settings in which bidders compete and winners are determined based on an unknown function of bids, bidder characteristics, and auctioneers' unobserved preferences.[19]

[18] See Asker and Cantillon (2008) and related papers for literature on scoring auctions. In standard scoring auctions bidders submit multi-dimensional bids, whereas in my model state governments optimally choose b_{js} but not x_s, ξ_s.

[19] See Krasnokutskaya et al. (2017) for discussion of various non-standard auction formats.

4.4 Model simplifications

This model makes at least four important simplifications. First, I assume that all states compete for all firms in the sense that all states are potential bidders. Because I do not observe losing bids, there will be no meaningful distinction between a state's choice not to bid for a firm and the choice to make a very low bid with essentially no chance of winning. Second, I assume that states and firms cannot breach incentive agreements (i.e. j must deliver v_{js} to s and s must deliver b_{js} to j). This assumption is occasionally violated in reality, as discussed in Section 2. The dynamic aspect to how governments and firms negotiate over incentive contracts is outside the scope of this paper. Third, I assume that each state endorses one location within state as a representative location. I treat π_{js} as the highest profit j can realize from different locations within s and abstract away from the possibility of local competition to focus on state competition. Fourth, this model cannot account for possible spillovers across states, which would be a source of efficiency loss generated by competition. Cross-state spillovers would be relevant for state competition within same metropolitan areas or regions surrounding state borders; well-known examples include competition between Kansas and Missouri in Kansas City and ongoing competition among states in Washington D.C. area for Amazon HQ2.

4.5 Welfare implications of state government competition: an illustration

Using a numerical example, I illustrate the welfare implications of state government competition in my model. For simplicity, I consider an environment with two states and J identical firms. Assume that the firm profit function is given by

$$\pi_{js} = x_s^\pi + \beta^b b_{js} + \epsilon_{js},$$

where x_s^π is a scalar, and ϵ_{js} is an iid draw from the Type I Extreme Value distribution. I further define $\mathcal{J}_{ss'}$ as the subset of firms that choose state s without competition and state s' with competition as follows:

$$\mathcal{J}_{ss'} \equiv \left\{ j \in \mathcal{J} \;\middle|\; x_s^\pi + \epsilon_{js} > x_{s'}^\pi + \epsilon_{js'},\; \beta^b b_{js} + x_s^\pi + \epsilon_{js} < \beta^b b_{js'} + x_{s'}^\pi + \epsilon_{js'} \right\}.$$

State 1 gains from competition by attracting firms that would have chosen state 2 if states did not compete (i.e., $j \in \mathcal{J}_{21}$). State 1 loses from competition by: (1) losing firms that would have chosen state 1 if states did not compete (i.e., $j \in \mathcal{J}_{12}$); and (2) paying incentives to firms that would have chosen state 1 regardless of whether states compete (i.e., $j \in \mathcal{J}_{11}$). State 1's welfare change is the difference between these gain and losses as derived below. In these derivations, I account for the deadweight loss of taxation incurred by incentive provision and use $\delta = (1 + \text{DWL})$ as the total public cost of paying one dollar in incentives. State 2's welfare change from competition can be similarly derived.

$$\text{State 1's welfare } \Delta = \sum_{j=1}^{J} \Big\{ \mathbb{1}(j \in \mathcal{J}_{21}) \cdot (v_{j1} - \delta b_{j1}) - \mathbb{1}(j \in \mathcal{J}_{12}) \cdot (v_{j1}) - \mathbb{1}(j \in \mathcal{J}_{11}) \cdot (\delta b_{j1}) \Big\}.$$

This derivation shows that competition would improve state 1's welfare if firms are likely to choose state 1 only when states compete so that most firms are in $\mathcal{J}_{21}$. This would require that: (1) state 1 has lower profitability for firms than state 2 ($x_1^{\pi} < x_2^{\pi}$) so that firms are more likely to choose state 2 in absence of state competition; (2) state 1 has higher valuations for firms than state 2 ($v_{j1} > v_{j2}$) so that state 1 can offer higher incentives than state 2; and (3) firm choices are sufficiently responsive to incentives.

On the other hand, firms can only gain from competition. The change in total firm profits is derived as

$$\text{Profit } \Delta = \sum_{j=1}^{J} \Big\{ \mathbb{1}(j \in \mathcal{J}_{12}) \cdot (\beta^b b_{j2} + x_2^{\pi} - x_1^{\pi} + \epsilon_{j2} - \epsilon_{j1}) + \mathbb{1}(j \in \mathcal{J}_{21}) \cdot (\beta^b b_{j1} + x_1^{\pi} - x_2^{\pi} + \epsilon_{j1} - \epsilon_{j2}) + \mathbb{1}(j \in \mathcal{J}_{11}) \cdot (\beta^b b_{j1}) + \mathbb{1}(j \in \mathcal{J}_{22}) \cdot (\beta^b b_{j2}) \Big\}.$$

The first two terms in this derivation show that when competition alters a firm's choice (i.e., $j \in \mathcal{J}_{12}, \mathcal{J}_{21}$), the firm is at least compensated for choosing a state that would not have maximized its profit had there been no competition. The last two terms show that when competition does not alter a firm's choice (i.e., $j \in \mathcal{J}_{11}, \mathcal{J}_{22}$), the firm receives government transfers from the state that would have maximized its profit even without competition.

Overall welfare change is the sum of changes in states' welfare and firm profits:

$$\text{Overall welfare } \Delta = \text{State 1's welfare } \Delta \; + \; \text{State 2's welfare } \Delta \; + \; \frac{\text{Profit } \Delta}{\beta^b}.$$

In the following simulation exercises, I assume $x_1^{\pi} > x_2^{\pi}$ so that, without incentive provision, state 1 is, on average, more profitable for firms than state 2. I further assume that incentive provision incurs deadweight loss of taxation of 25% ($\delta = 1.25$). Details of the simulation procedures are provided in the appendix.

4.5.1 Correlation between state valuations and firm profits

The left plot of Figure 3 shows the simulation results when $\text{Cov}(\text{E}(v_{js}), x_s^{\pi}) = 2$. Competition lowers welfare in this case. With competition, firms are still more likely to choose state 1, since $\text{E}(v_{j1}) > \text{E}(v_{j2})$ so that state 1 is more likely to have higher valuations for firms than state 2 and also have the capacity to offer higher incentives than state 2. Incentives paid to such immobile firms are costly government transfers when considering the deadweight loss of taxation, which drives welfare reduction. The left plot of Figure 4 shows that competition has negligible impact on states' winning probabilities. In the center and right plots of Figure 3, $\text{Cov}(\text{E}(v_{js}), x_s^{\pi})$ is equal to -8 and

−14 respectively. In these cases, competition increases welfare in some regions. Intuitively, when state 2 is more likely to have higher valuations for firms than state 1, competition *may* improve welfare by giving state 2 higher probability of attracting firms that would not have chosen state 2 without incentives.

4.5.2 Heterogeneity in state valuations for firms

The center and right plots in Figure 3 shows the simulation results when $\mathrm{E}(v_{j2}) - \mathrm{E}(v_{j1})$ is equal to 4 and 7 respectively, keeping (x_1^π, x_2^π) the same. Welfare gain from competition is noticeably larger in the right plot. Intuitively, as state valuations for firms become more heterogeneous, competition generates larger efficiency gains by enabling state 2 to leverage its higher valuations and attract more firms that would not chosen state 2 without incentives. The center and right plots in Figure 4 show that state 2's winning probability with competition is substantially higher than that without competition when state valuations are more heterogeneous.

4.5.3 Sensitivity of firm choices to incentives

The center and right plots of Figure 3 show that welfare gain from competition increases with β^b. Intuitively, as incentives become more important for firm choices, firms become more likely to choose state 2 which tends to offer higher incentives than state 1. Since welfare gain from competition is derived from firms choosing states with the highest valuations for firms that would not have been chosen without incentives, higher β^b translates into larger welfare gains. The center and right plots of Figure 4 show that the difference between state 2's winning probability with and without competition increases with β^b as well.

5 Identification

In this section, I provide intuition for identification of state valuation distributions and firm profit function parameters.

5.1 State valuation distributions

First-order conditions for states' optimal bid strategies (Equation 4) provide a way of inferring state valuations for firms using observations on accepted incentives. This approach follows a standard method shown by Guerre et al. (2000) in the first-price auction literature. I duplicate Equation 4 below for convenience:

$$v = b + \frac{w_{js}(b)}{w'_{js}(b)}.$$

This equation shows that the distribution of state s's valuations for firm j, $F_V(\cdot|x_{js}^v, \chi_{js}^\pi)$, can be recovered if I know: (1) the equilibrium bid distribution of s, $G_B(\cdot|x_{js}^v, \chi_{js}^\pi)$; and (2) the strategic markdown of s associated with equilibrium bid b, $\frac{w_{js}(b)}{w'_{js}(b)}$. As shown by Equation 5, the latter is a function of the equilibrium bid distributions of s's opponents, $\left\{G_B(\cdot|x^v_{js'}, \chi^\pi_{js'})\right\}_{s'\in\mathcal{S}\setminus s}$. Therefore, the equilibrium bid distributions of all states, $\left\{G_B(\cdot|x^v_{js}, \chi^\pi_{js})\right\}_{s\in\mathcal{S}}$, is necessary to recover $F_V(\cdot|x^v_{js}, \chi^\pi_{js})$.[20]

In order to identify $\left\{G_B(\cdot|x^v_{js}, \chi^\pi_{js})\right\}_{s\in\mathcal{S}}$ using empirical distributions of accepted incentives, $\left\{G_B(\cdot|j \text{ accepts } s\text{'s offers}, x^v_{js}, \chi^\pi_{js})\right\}_{s\in\mathcal{S}}$, I express s's equilibrium bid density function, denoted by $g_B(\cdot|x^v_{js}, \chi^\pi_{js})$, as follows:[21]

$$g_B(b|x^v_{js}, \chi^\pi_{js}) = \frac{g_B(b|j \text{ accepts } s\text{'s offers}, x^v_{js}, \chi^\pi_{js}) \cdot \Pr(j \text{ accepts } s\text{'s offers})}{w_{js}(b)}. \tag{6}$$

This equation is derived by expressing $g_B(b|j \text{ accepts } s\text{'s offers}, x^v_{js}, \chi^\pi_{js})$ using the definition of conditional probability as shown in the appendix. Numerator of the right-hand side in Equation 6 consists of observables; $\Pr(j \text{ accepts } s\text{'s offers})$ is the relative frequency of j accepting s's offers. All other terms in the equation are functions of unknown $\left\{g_B(\cdot|x^v_{js}, \chi^\pi_{js})\right\}_{s\in\mathcal{S}}$.

$\left\{g_B(\cdot|x^v_{js}, \chi^\pi_{js})\right\}_{s\in\mathcal{S}}$ is the solution to the system of functional equations formed by stacking Equation 6 for all states. Given that the equilibrium bid density function is fully parameterized with x^v_{js}, χ^π_{js}, I can recover $\left\{g_B(\cdot|x^v_{js}, \chi^\pi_{js})\right\}_{s\in\mathcal{S}}$ by solving for a fixed number of parameters.

5.2 Firm profit function parameters

I use variation in distributions of accepted incentives conditional on observable determinants of state valuations (x^v_{js}) to identify firm profit function parameters, $\theta^\pi = (\beta^x, \beta^b, \beta^d, \xi)$. As state valuation distributions are fully parameterized with x^v_{js}, variation in distributions of accepted incentives conditional on x^v_{js} would be attributed to variation in firm profitabilities across states. For example, conditional on x^v_{js}, a state that is less profitable for firms would, on average, bid more aggressively to attract firms and pay higher incentives. If firms were completely indifferent to state attributes, $\chi^\pi_{js} = (x^\pi_s, d_{js}, \xi_s)$, entering the firm profit function and only cared about incentives, the conditional distributions of accepted incentives would be invariant to χ^π_{js} (i.e., $G_B(\cdot|j \text{ accepts } s\text{'s offers}, x^v_{js}) = G_B(\cdot|j \text{ accepts } s\text{'s offers}, x^v_{js}, \chi^\pi_{js})$. This is because states' equilibrium bid strategies and distributions would be invariant to χ^π_{js} (i.e., $G_B(\cdot|x^v_{js}) = G_B(\cdot|x^v_{js}, \chi^\pi_{js})$). On the other hand, if χ^π_{js} were relatively more important for firm profits, conditional distributions of accepted incentives would now vary with χ^π_{js}, since states' equilibrium bid strategies and distributions would vary with χ^π_{js}. Variation in firms' headquarter locations (d_{js}), which are likely exogenous to state valuations, further allows me to exploit within-state variation in accepted incentives conditional on firm attributes that determine state valuations. Following the same line of

[20] Equation 5 shows that the firm profit function parameters are also necessary to compute $w_{js}(b)$.

[21] In standard first-price auctions, winning bid distributions are sufficient to identify equilibrium bid distributions (Theorem 3.2 in Athey and Haile (2007)).

argument as above, I use how each state's conditional distribution of accepted incentives vary with distances to infer the relative importance of distances versus incentives for firm profits.

6 Estimation

I use the method of simulated moments to estimate $\theta^\pi = (\beta^x, \beta^b, \xi)$ and $\left\{F_V(\cdot|x^v_{js})\right\}_{s\in\mathcal{S}}$. To simulate state government competition and firm location choice, I first specify the firm profit function and states' equilibrium bid distributions.[22] I use the firm profit function as specified in Equation 2. I specify states' equilibrium bid distributions, $G_B(\cdot|x^v_{js}, \chi^\pi_{js})$, as a log-normal distribution with its log mean and standard deviation parameterized as follows:[23]

$$\mu_{js} = \mu^0 + \mu^1 x^v_{js} + \mu^2\left(\beta^{x0}x^\pi_s + \beta^d d_{js} + \xi_s\right)$$
$$\sigma_{js} = \sigma^0 + \sigma^1 x^v_{js}.$$

I include x^v_{js} and $\beta^{x0}x^\pi_s + \beta^d d_{js} + \xi_s$ in this specification to parsimoniously capture the model prediction that states' equilibrium bids are functions of both their valuations and profitabilities for firms. Parameters of the equilibrium bid distribution are denoted by $\theta^b = (\mu, \sigma)$.

Based on suggestive evidence from Section 3, I include in x^π_s the likely determinants of firm profits: college attainment rate, population, corporate income tax rate, right-to-work law status, wage, and vehicle-miles of travel. I include in x^v_{js} the likely determinants of states' valuations for firms: number of jobs, manufacturing dummy, unemployment rate, and vote share difference between Democratic and Republican candidates in gubernatorial elections.

Using above specifications for firm profit function and states' equilibrium bid distributions, I simulate the model for each candidate vector of (θ^π, θ^b) in following steps. First, I draw firm characteristics (number of jobs, manufacturing dummy, and headquarter location) from the empirical distribution. Second, for each draw of firm j, I simulate state government competition by drawing states' incentive offers from specified equilibrium bid distributions. Third, I simulate each j's location choice by drawing j's latent preferences ($\zeta = (\zeta_{j1}, \cdots, \zeta_{jK})$ and $\epsilon = (\epsilon_{j1}, \cdots, \epsilon_{jS})$ from standard normal and Type I Extreme Value distributions respectively) and choosing the state that maximizes j's total profit. Draws of firm characteristics and latent firm preferences are kept constant for each candidate (θ^π, θ^b).

I use the following four sets of moments to estimate (θ^π, θ^b): (1) mean, variance, and selected quantiles of each state's distribution of accepted incentives conditional on job bins; (2) covariance between accepted incentives and awarding state characteristics; (3) covariance between firm char-

[22] I use parametric equilibrium bid distributions to avoid solving for equilibrium bid strategies, which can be computationally burdensome.

[23] Model implies that equilibrium bid distributions have finite upper bounds. Following Athey et al. (2011), I truncate upper tails of the estimated equilibrium bid distributions. I truncate less than 0.003% of bids with corresponding valuation higher than $0.25 mil/job.

acteristics and chosen state characteristics; and (4) share of firms in each state by job bins.[24][25] Denoting the vector of empirical moments by m^{data} and the vector of simulated moments by m^{sim}, I search for $\theta = (\theta^{\pi}, \theta^{b})$ that minimizes the distance between the simulated and empirical moments as follows:

$$\min_{\theta}(m^{data} - m^{sim}(\theta))J(m^{data} - m^{sim}(\theta))',$$

where J indicates the weight matrix.[26]

With estimated $(\theta^{\pi}, \theta^{b})$, I recover $\left\{F_V(\cdot|x^{v}_{js})\right\}_{s\in\mathcal{S}}$ using the first-order conditions for states' optimal bid strategies. In specific, for each s, I draw bids from the estimated $G_B(\cdot|x^{v}_{js}, \chi^{\pi}_{js})$ and compute $\frac{w_{js}(b)}{w'_{js}(b)}$ for each bid draw b using numerical integration which requires draws of opponent states' bids from estimated $\left\{G_B(\cdot|x^{v}_{js'}, \chi^{\pi}_{js'})\right\}_{s'\in\mathcal{S}\setminus s}$ (see Equation 5). b and $\frac{w_{js}(b)}{w'_{js}(b)}$ are then plugged into Equation 4 to recover the valuation corresponding to b.

7 Results

In this section, I discuss estimation results that are reported in Table 3; I use results from the first specification which includes random coefficients in the firm profit function. Results from both specifications are qualitatively similar, but the results from the first specification are more stable. Figure 14 compares empirical and simulated unconditional densities of accepted incentives for each state, and Table 4 compares empirical and simulated shares of firms for each state by job bins. My discussion of results focuses on features of state valuations and firm preferences that shape welfare implications of state government competition as presented in Section 4.5: (1) sensitivity of firm choices to incentives; (2) heterogeneity in state valuations; and (3) correlation between state valuations and firm profits. Throughout my discussion, I assume that the representative firm is a manufacturing firm with 200 jobs headquartered in New York in 2006.

7.1 Sensitivity of firm choices to incentives

Panel A of Table 3 shows that the proposed determinants of firm profitabilities (x^{π}_{s}, d_{js}) impact firm profits in anticipated directions. I use the parameter estimates and Equation 5 to compute $w_{js}(\bar{b}_{js})$, the probability of the representative firm j accepting $\bar{b}_{js}$ from state s, where $\bar{b}_{js}$ is the mean of estimated equilibrium bid distribution of s. Figure 5 shows that states with lower $\bar{b}_{js}$ tend to have higher implied $w_{js}(\bar{b}_{js})$. This pattern hints at the relative insignificance of incentives for firm choices, since states that offer lower average incentives are facing higher chances of landing firms, likely because such states have more profitable attributes for firms such as larger population and higher college attainment rate. Figure 6 confirms that $w_{js}(\bar{b}_{js})$ is largely driven by $\bar{\pi}_{js}$, the

[24] When computing the first set of moments, I pool states that have only a few observations.

[25] For the empirical portion of the fourth moment, I use the number of establishments reported in the 2007-2008 Statistics of the U.S. Businesses.

[26] I use a diagonal weight matrix for J as the moment functions are highly collinear.

deterministic profitability of state s for firm j: $\overline{\pi}_{js} = \beta^{x0} x_s^{\pi} + \beta^d d_{js} + \xi_s$. Heterogeneity in $\overline{\pi}_{js}$ across states is substantial; horizontal axis of Figure 6 indicates that $\overline{\pi}_{js}$ ranges from 3 to 6 million dollars. Table 5 also shows that the implied dollar values of state attributes are fairly large. Lastly, Figure 7 shows that the elasticities of $w_{js}(\overline{b}_{js})$ to $\overline{b}_{js}$ are low; increasing s's incentive offer by 1% from $\overline{b}_{js}$ raises the probability of j accepting the offer by less than 0.5% for most states. Overall, I find that firm location choices are relatively insensitive to incentives and driven mostly by key state attributes. This insensitivity to incentives would reduce the likelihood of firms choosing states with high valuations for firms that would not have been chosen without incentives, hence rendering state government competition less likely to improve welfare.

7.2 Heterogeneity in state valuations for firms

Panel B in Table 3 shows that the proposed determinants of state valuations (x_{js}^v) impact equilibrium bids in anticipated directions and that equilibrium bids are decreasing in $\bar{\pi}_{js}$. I use the parameter estimates and Equation 4 to compute distributions of states' valuations for the representative firm. Figure 8 shows, as an example, California and Nevada's valuations and equilibrium bids. The densities of California's valuations and equilibrium bids are less dispersed than those of Nevada's. Plots of equilibrium bid functions also show that for the same valuation draw, California bids lower than Nevada and that Nevada is more likely to draw higher valuations. Vertical axes of Figures 9 and 10 indicate that state valuations for firms are substantially heterogeneous; average valuations for the representative firm range from 1.25 to 2.25 million dollars. This substantial heterogeneity in valuations would allow government competition to deliver larger welfare gains given that states with higher valuations for firms are less likely to attract firms without incentives. Consistent with the suggestive findings from Section 3, I find that much of the heterogeneity in state valuations is explained by local economic and political conditions. Figure 9 shows that more Republican states tend to have higher average valuations, suggesting that local political factors impact how state governments formulate their valuations for firms. Figure 10 shows that states with higher unemployment rates tend to have higher average valuations likely because such states are in more dire need of jobs.

7.3 Correlation between state valuations and firm profits

As discussed in Section 4.5, the correlation between state valuations and firm profits is crucial for determining whether there is scope for welfare gains to be generated by government competition. Figure 11 shows that states with higher average valuations for firms tend to have lower deterministic firm profitabilities ($\overline{\pi}_{js}$). This negative correlation implies that under competition, states with lower firm profitabilities are more likely to attract firms that would not have chosen them without incentives, since such states can leverage their higher valuations to make higher incentive offers.

8 Welfare consequences of state government competition

Based on previous section's discussion, whether competition improves the overall welfare of states and firms is not obvious, as estimation results show that there are opposing effects at play. While the substantial heterogeneity in state valuations and the negative correlation between state valuations and firm profits imply that competition is likely to generate welfare gains, the relative unresponsiveness of firm choices to incentives implies the opposite.

I consider a counterfactual elimination of government competition and compare simulated welfare in this counterfactual to the one simulated under competition. In specific, I first simulate firm choices with competition as in the original model and compute resulting welfare of states and firms. I then remove incentives from firm profits, simulate firm choices, and compute resulting welfare. This second simulation corresponds to counterfactual elimination of competition. To compare welfare in these two simulations, I maintain the same draws of firm characteristics, random firm preferences (ζ, ϵ), and states' equilibrium bids and valuations. I also restrict the difference in valuation per job of winning states with and without competition to be less than 75,000 dollars; relaxing this restriction would result in higher welfare gains from competition.

I measure welfare as the sum of state valuations and firm profits as presented in Section 4.5. Welfare change generated by competition is derived as follows:

$$\text{Overall welfare } \Delta = \sum_{j \in \mathcal{J}} \sum_{s \in \mathcal{S}} \Bigg[\underbrace{\left\{ \mathbb{1}\left(c(j)=s\right)\left(\frac{\pi_{js}}{\beta^b}\right) - \mathbb{1}\left(\tilde{c}(j)=s\right)\left(\frac{\pi_{js}-\beta^b b_{js}}{\beta^b}\right)\right\}}_{\text{Change in firm profits}} + \underbrace{\left\{ \mathbb{1}\left(c(j)=s\right)\left(v_{js}-\delta \cdot b_{js}\right) - \mathbb{1}\left(\tilde{c}(j)=s\right)\left(v_{js}\right)\right\}}_{\text{Change in state welfare}} \Bigg],$$

where $c(j)$ and $\tilde{c}(j)$ indicate states chosen by j with and without competition respectively. I assume the deadweight loss of taxation to be 0.25 (i.e., $\delta = 1.25$), which captures the efficiency loss that arises from using tax dollars to pay incentives.[27]

Panel A of Table 6 shows that roughly 70% of firms choose the same states regardless of whether states compete; similar percentage of jobs remain in the same states.[28] This inertia in firm choices arises from the relative unresponsiveness of firms choices to incentives as discussed in Section 7. The sum of incentives provided to such immobile firms amounts to 17% of total simulated incentives; in other words, 83% of incentives are paid to make roughly 30% of firms choose states different from what would have been chosen without incentive offers. Since firm choices are relatively unresponsive to incentives, a large share of incentives is used to alter location choices of a small share of firms.

Panel B of Table 6 shows that competition improves the overall welfare of states and firms by about 9% despite the deadweight loss of taxation. This welfare improvement is largely driven

[27] 0.25 is within a range of existing estimates of deadweight loss of taxation in the Public Finance literature (e.g., (Chetty, 2009)). Higher measures would imply lower welfare gains from competition.

[28] Similarly, Mast (2018) finds that about 85% of firms would choose the same towns in New York regardless of whether property tax exemptions are provided.

by an increase in firm profits. Firm profits increase by 11% while state valuations increase more modestly by less than 1%. Firms benefit substantially by capturing rents from states, especially when they choose less profitable (higher valuation) states that they would not have chosen without incentives. Firm profits increase by 26% when firm choices are altered by incentives compared to 4% when firm choices are unaltered; as firm choices are relatively unresponsive to incentives, firms are more likely to alter their choices when states draw very high valuations and bid correspondingly high equilibrium incentive offers. In other words, firms are substantially overcompensated when they choose what would have been less profitable states without incentives. I confirm that when a firm's choice is altered, the winning state under competition has a substantially higher valuation for the firm than the winning state without competition; the average difference between valuations of winning states with and without competition for mobile firms is $6.8 million.[29]

Figure 12 shows that under competition, less profitable (higher valuation) states attract jobs away from more profitable (lower valuation) states. Nonetheless, Figure 13 shows that welfare change is positive for a relatively few states when the deadweight loss of taxation is taken into account. Overall state welfare improves only modestly for two reasons. First, states are mostly paying incentives to immobile firms; such incentives incur efficiency loss, as they are costly government transfers when considering the deadweight loss of taxation. Second, when competition alters firm choices, much of the heterogeneity in state valuations is taken away due to competition and the deadweight loss of taxation. States are paying roughly 60% of their valuations to alter firm choices. When incentive payments and the resulting deadweight loss of taxation are subtracted, valuations realized by the states that attract "new" firms under competition are not sufficiently higher than the valuations of states that would have attracted those same firms in absence of competition. On the other hand, I find that competition substantially improves state welfare if I assume that incentive provision does not incur deadweight loss of taxation (i.e., $\delta = 1$); under this assumption, states would be internalizing the deadweight loss of taxation into their valuations for firms.[30] In this case, I find that state and overall welfare increase by 25% and 13% respectively; firm profits still increase by 11%, which is invariant to assumptions on δ. The large change in state welfare arises from shutting down one major driver of welfare loss for states. Although welfare calculations vary with δ, even a relatively conservative calculation with $\delta = 1.25$ shows that government competition improves the overall welfare of states and firms.

8.1 Discussion

While I find in this section that state government competition improves the overall welfare of states and firms, whether the substantial transfer of rents from states to firms induced by competition

[29] i.e., $\sum_{j \in \hat{J}} \left(v_{jc(j)} - v_{j\tilde{c}(j)} \right) / |\hat{J}| = \$6.8$ million, where $\hat{J} = \{ j \in \mathcal{J} | c(j) \neq \tilde{c}(j) \}$

[30] Anecdotal evidence suggests that incentive provision often results in depreciation of public goods and services that appear to not have been fully incorporated into governments' valuations for firms and bid strategies (e.g., https://www.nytimes.com/2012/12/02/us/how-local-taxpayers-bankroll-corporations.html and https://www.nytimes.com/2018/04/24/opinion/amazon-hq2-incentives-taxes.html).

is socially desirable is a normative question.[31] My welfare calculations assuming $\delta = 1.25$ suggest that competition is likely to be an ineffective solution if local economic development is prioritized, as states gain only modestly as a whole. There are at least two reasons why the economic gain for state residents is likely to be even lower than the state welfare gain that I calculate in this section. First, as I find that a substantial part of the state valuations for firms is explained by a political variable, economic gains for state residents are likely to be lower than the state welfare gain that I calculate using estimated state valuations. Second, state welfare gain will be lower if the benefits of attracting a firm are shared by multiple states and states do not internalize this cross-state spillover into their equilibrium bid strategies.

9 Conclusion

Using data on accepted incentives to learn about state valuations for firms and firms' geographic preferences, I provide empirical evidence that state government competition using incentives improves the overall welfare of states and firms. Firms benefit substantially by having states compete for them and by capturing rents. States, on the other hand, benefit modestly when considering the deadweight loss of taxation; states are mostly paying incentives to immobile firms and much of the heterogeneity in valuations is lost even when firm choices are altered by competition. These findings are consistent with the view that state competition generates large corporate welfare and little allocative efficiency when considering the deadweight loss of taxation but does not fit the view that competition lowers overall welfare.

Either due to lack of data or for tractability, I made important simplifications in this paper that may be relaxed in a future research. The notion of state valuations for firms introduced in this paper does not arise from a particular mechanism and is difficult to interpret. Data on how an arrival of a firm impacts local outcomes would be informative of how well such valuations capture realized local economic benefits, which are often the subject of interest in assessments of place-based policies (e.g., Greenstone et al. (2010), Patrick (2016)). Data on unaccepted incentive offers would allow model primitives to be identified without assuming which states are competing for each firm. Lastly, the rich heterogeneity in types of incentives, the dynamic aspects of an incentive contract, and possible cross-state spillovers of benefits of attracting firms may be studied in richer models as well.

[31] Glaeser (2001) discusses various aspects of the debate on the social desirability of government transfers to firms.

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Tables and Figures

Table 1: Summary statistics

Statistic	N	Mean	St. Dev.	Median	Min	Max
Panel A: Accepted incentives and firm characteristics						
Incentives ($ mil)	117300	1.59	41.02	0.07	0.01	8700
Incentives per job ($ mil/job)	39859	0.03	0.27	3.34e-03	3.14e-07	20.24
Jobs	39859	172.49	989.63	45	1	120262
Hourly wage ($)	4629	18.49	11.20	15.23	6	96
Investment ($ mil)	34626	29.85	641.15	1.97	1e-05	1e+05
Manufacturer	28994	0.57	0.49	1	0	1
Distance from HQ (thou km)	16860	1.07	1.07	0.78	0	4.31
Panel B: State characteristics						
Population (mil)	589	7.21	6.59	5.48	0.57	39.25
College attainment rate (%)	462	9.40	3.24	8.7	4.5	27.5
Right-to-work law	589	0.44	0.50	0	0	1
Unemployment rate (%)	591	6.21	2.06	5.80	2.30	13.66
Corporate income tax rate (%)	542	6.47	2.82	6.9	0	12
Vote % diff (Dem-Rep) in gubernatorial elections	498	-4.38	19.17	-3.8	-58.4	44.1
Median monthly rent in 2016 ($)	47	888.30	171.31	816	658	13
Mean hourly wage ($)	564	9.97	3.57	19.47	13.06	39.88
Per capita income ($ thou)	583	39.23	7.92	38.12	21.54	69.09
Mfg employees in 2016 (ten thou)	47	23.46	22.28	16.01	1.22	111.99
Enplanements in 2016 (logs)	46	116.02	122.22	79.38	21.84	791.39
Waterborne tonnage in 2016 (thou)	37	77.25	117.10	40.94	5	545.10
Vehicle-miles of travel in 2016 (bil)	47	66.75	65.90	52.15	5.26	340.12
Number of Metropolitan Statistical Areas in 2010	47	9.17	6.06	8	1	26

Notes: Years and data sources are shown in the appendix.

Table 2: Descriptive regression

	Dependent variable:		
	Accepted incentives ($ mil)		
	(1)	(2)	(3)
Jobs	0.028^{***}	0.053^{***}	0.055^{***}
	(0.0003)	(0.001)	(0.001)
Manufacturer		5.260^{***}	6.333^{**}
		(1.416)	(2.732)
Unemployment rate (%)	0.558^{***}	1.913^{***}	2.674^{***}
	(0.148)	(0.407)	(0.744)
Vote % (D-R)	-0.027^{*}	-0.140^{***}	-0.155^{*}
	(0.016)	(0.042)	(0.081)
# MSA	-0.347^{***}	-1.181^{***}	-1.254^{***}
	(0.072)	(0.184)	(0.338)
College attainment rate (%)	-0.988^{***}	-2.214^{***}	-3.708^{***}
	(0.200)	(0.555)	(1.023)
Corporate income tax rate (%)	0.012	−0.317	0.289
	(0.152)	(0.421)	(0.697)
Right-to-work law	0.104	1.792	2.734
	(0.890)	(2.257)	(4.323)
Median monthly rent ($)	0.010^{***}	0.017^{**}	0.031^{**}
	(0.003)	(0.008)	(0.014)
Distance from HQ (thou km)			4.716^{***}
			(1.434)
Constant	0.119	−2.561	−16.619
	(2.653)	(7.094)	(13.313)
Observations	38,454	12,729	6,185
R^2	0.219	0.407	0.426

Notes: $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

Table 3: Parameter estimates

	(1)		(2)	
Panel A: Profit function				
College attainment rate	6.039		6.020	
	(0.004)		(35.106)	
× random coeff.	-0.044			
	(0.000)			
Log population	0.928		0.932	
	(0.021)		(0.031)	
× random coeff.	0.012			
	(0.038)			
Corporate income tax rate	-4.969		-4.976	
	(0.002)		(15.676)	
Right-to-work	0.150		0.148	
	(0.026)		(0.678)	
Mean hourly wage	-1.973		-1.983	
	(0.011)		(18.773)	
× random coeff.	0.016			
	(0.000)			
Vehicle-miles of travel	0.119		0.110	
	(0.027)		(0.033)	
Distance from HQ	-0.250		-0.262	
	(0.130)		(0.648)	
Incentive	0.899		0.615	
	(0.079)		(0.406)	
Panel B: Bid distribution				
	μ	σ	μ	σ
Jobs	0.009	-0.024	0.009	-0.025
	(0.001)	(0.008)	(0.000)	(0.008)
Manufacturer	0.039	-0.009	0.040	0.003
	(0.006)	(0.123)	(0.009)	(0.162)
Unemployment rate	0.511	0.034	0.515	0.037
	(0.091)	(0.015)	(0.302)	(1.644)
Vote % (Dem - Rep)	-0.036	0.170	-0.036	0.411
	(0.011)	(0.217)	(0.008)	(0.047)
Profitability	-0.038		-0.037	
	(0.003)		(0.005)	
Intercept	0.883	-2.203	0.883	-2.225
	(0.007)	(0.216)	(0.009)	(0.158)

Notes: Both specifications include state fixed effects in profit functions.

Table 4: Share of firms in each state by job bins (data vs. simulated)

State	Jobs $\in [100, 500]$		Jobs $\in [501, 1000]$	
	Data	Simulated	Data	Simulated
AL	0.021	0.035	0.022	0.042
CA	0.142	0.064	0.135	0.076
CO	0.022	0.017	0.025	0.015
CT	0.018	0.030	0.016	0.027
FL	0.067	0.053	0.085	0.055
GA	0.038	0.040	0.046	0.042
IA	0.020	0.021	0.013	0.024
IN	0.034	0.034	0.030	0.036
KS	0.017	0.026	0.013	0.025
KY	0.020	0.029	0.019	0.029
LA	0.020	0.038	0.019	0.036
MA	0.034	0.027	0.029	0.029
MD	0.024	0.023	0.025	0.019
MI	0.043	0.038	0.040	0.041
MO	0.030	0.020	0.028	0.025
MS	0.013	0.047	0.012	0.047
NC	0.041	0.036	0.043	0.039
NJ	0.031	0.028	0.035	0.039
NV	0.013	0.040	0.012	0.037
NY	0.073	0.078	0.064	0.070
OH	0.057	0.041	0.056	0.030
SC	0.019	0.038	0.021	0.030
TN	0.028	0.029	0.031	0.027
TX	0.096	0.089	0.109	0.084
UT	0.011	0.030	0.011	0.023
VA	0.037	0.027	0.040	0.032
WI	0.031	0.020	0.023	0.018

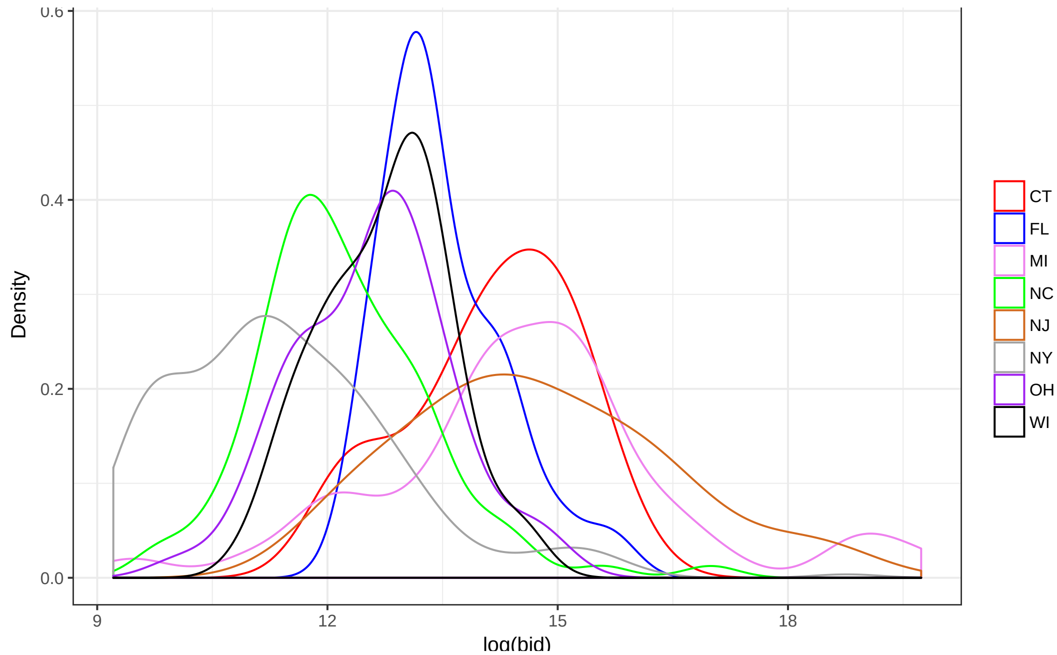
Table 5: Implied values of state attributes ($ million)

College attainment rate (%)	0.067
Log(population/100000)	1.033
Corporate income tax rate (%)	-0.055
Right-to-work	0.167
Mean hourly wage ($/hour)	-0.022
Vehicle-miles of travel (billion mi)	0.001
Distance from HQ (log thousand km)	-0.278

Table 6: Counterfactual elimination of state government competition

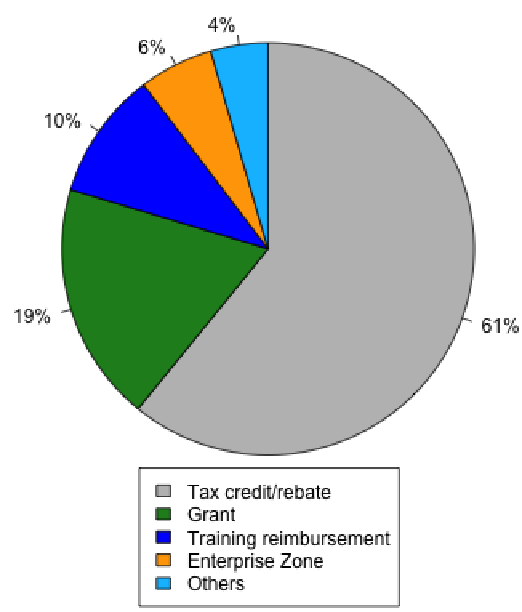
Panel A: Firm choices	
% immobile firms	69.40
% immobile jobs	67.52
% incentives provided to immobile firms	16.58
Panel B: Welfare change relative to no competition	
% change in firm profits	10.50
among immobile firms	4.27
among mobile firms	26.21
% change in state welfare assuming DWL=0.25	0.23
% change in state welfare assuming DWL=0	24.92
% change in overall welfare assuming DWL=0.25	8.89
% change in overall welfare assuming DWL=0	12.77

Figure 1: Density plots of accepted incentives



Notes: Density plots of log of incentives provided by the selected states to manufacturing firms with jobs $\in [100, 200]$ in 2000-2016.

Figure 2: Types of accepted incentives



Notes: Tax credit/rebate includes property tax abatement. Others include cost reimbursement (1.09%), industrial revenue bond (0.05%), grant/loan hybrid program (1.94%), tax increment financing (1.08%), infrastructure assistance (0.14%), and Megadeal (0.20%; this is a classification introduced by Good Jobs First and refers to incentives worth over $75 million).

Figure 3: Numerical example – welfare

Figure 4: Numerical example – win shares

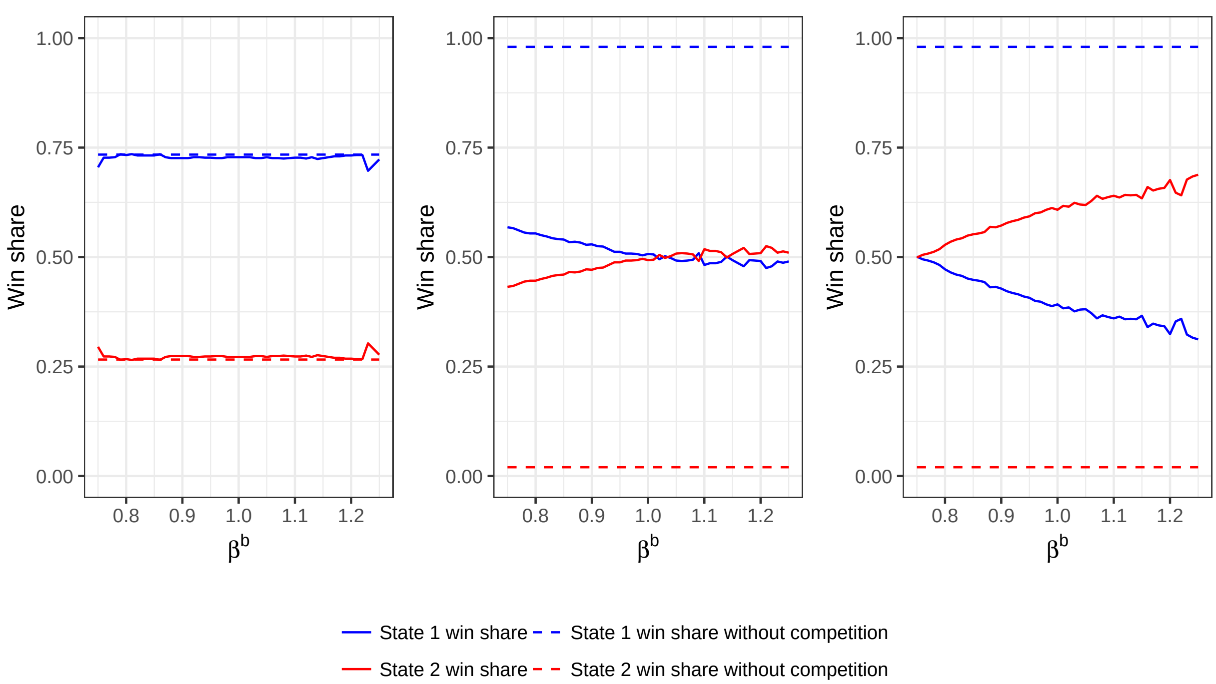
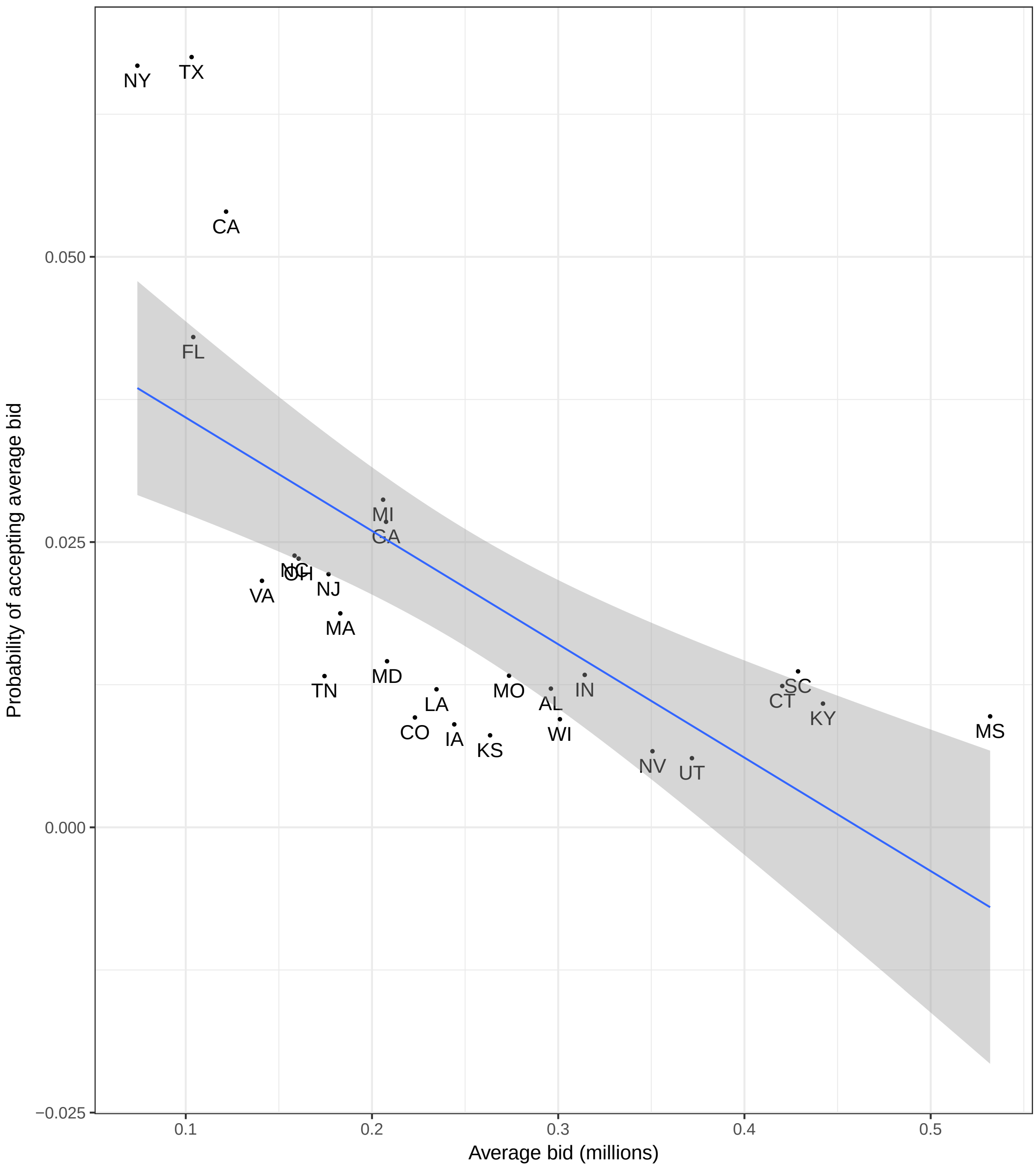
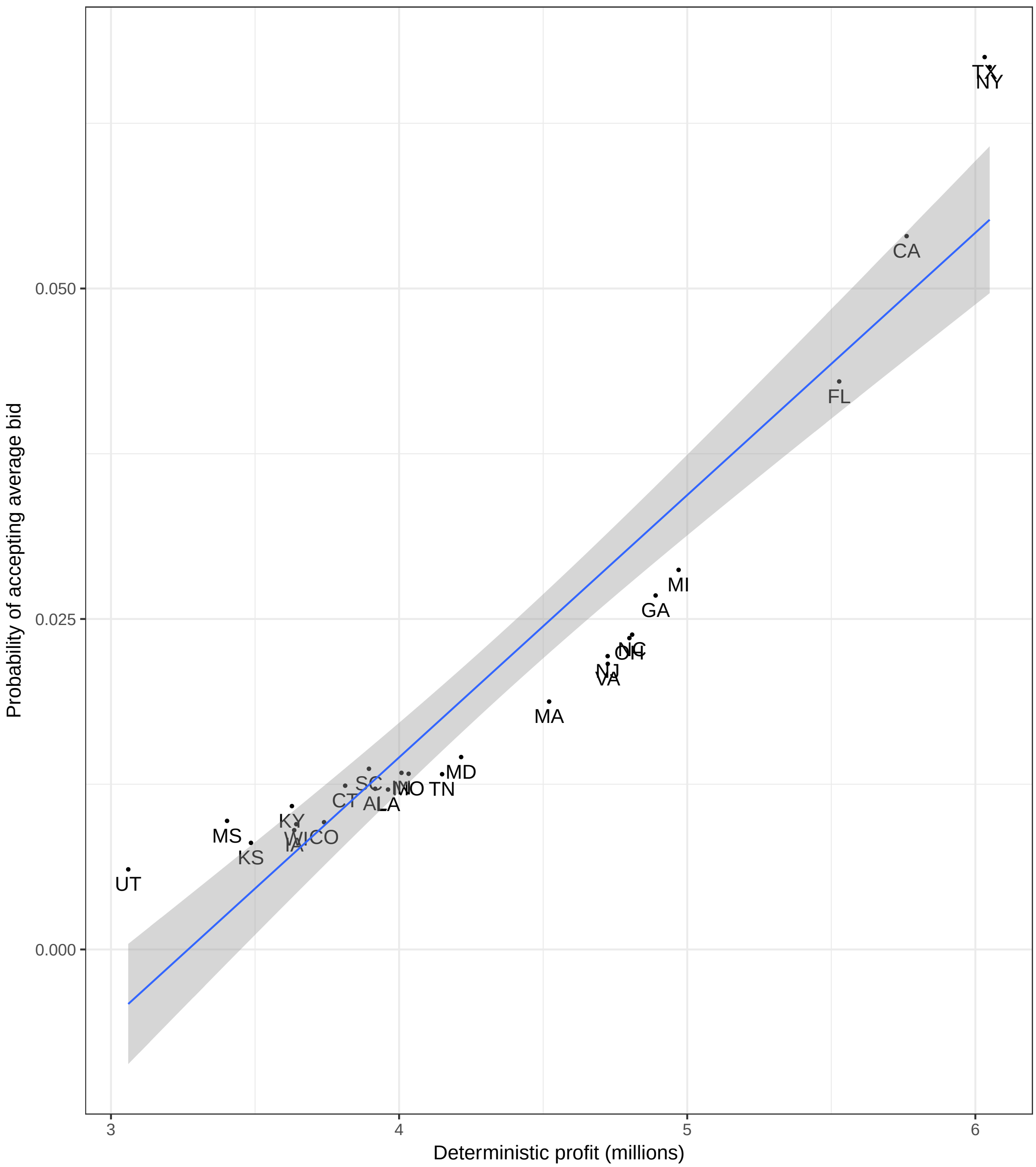


Figure 5: Probability of accepting average bid vs. average bid



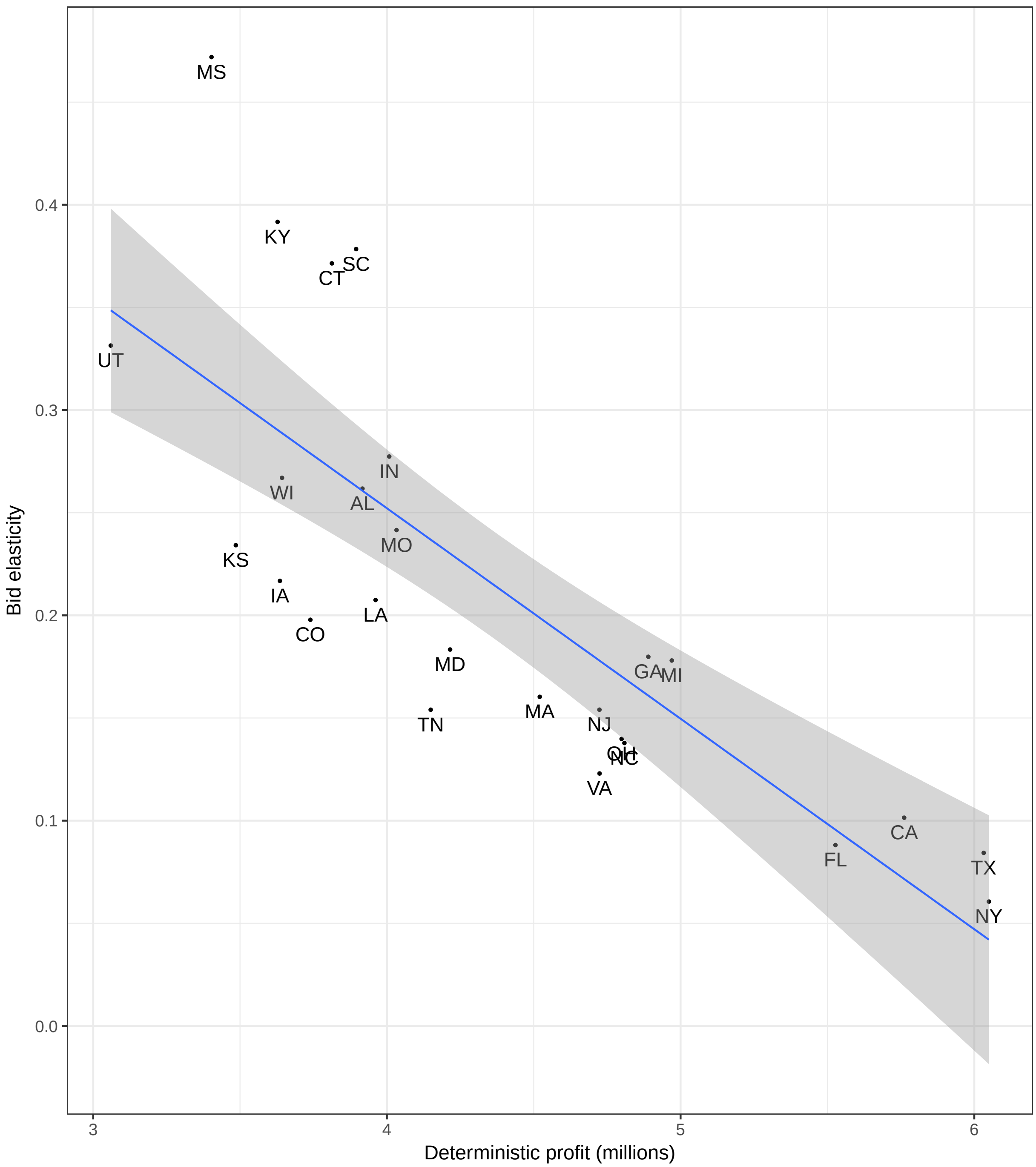
Notes: Representative firm is chosen to be a manufacturer headquartered in New York in 2006 with 200 jobs.

Figure 6: Probability of accepting average bid vs. deterministic profit



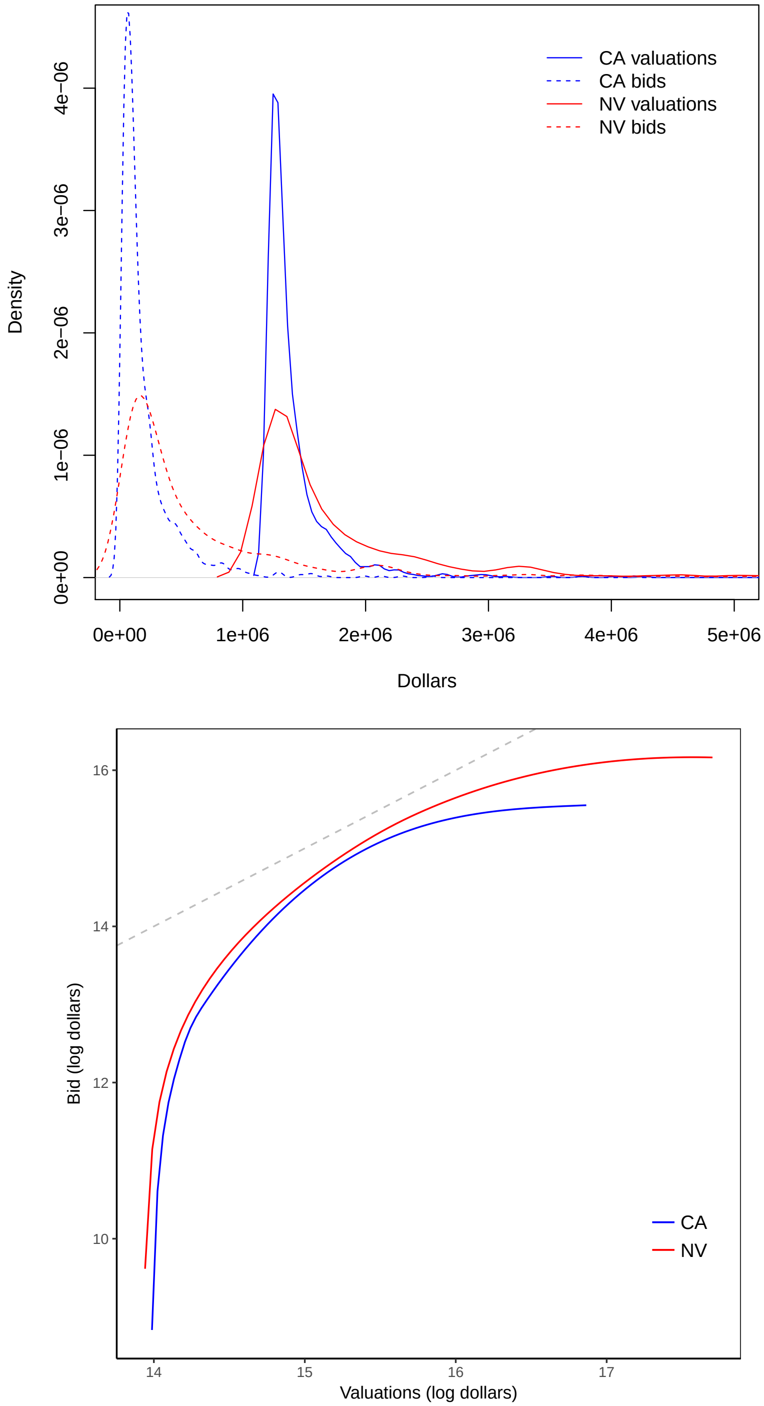
Notes: Representative firm is chosen to be a manufacturer headquartered in New York in 2006 with 200 jobs.

Figure 7: Bid elasticity vs. deterministic profit



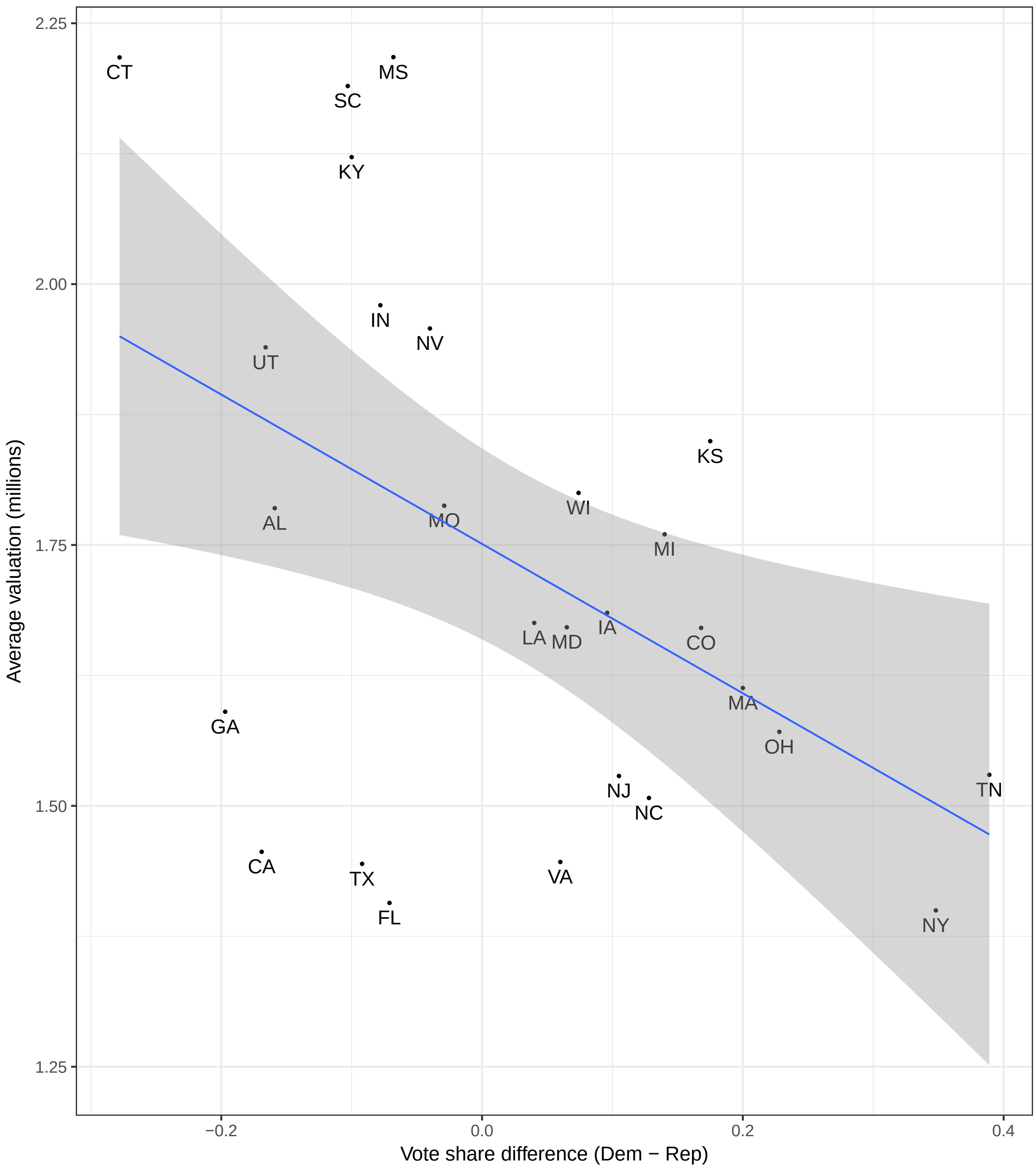
Notes: Representative firm is chosen to be a manufacturer headquartered in New York in 2006 with 200 jobs.

Figure 8: California and Nevada's valuations and equilibrium bids



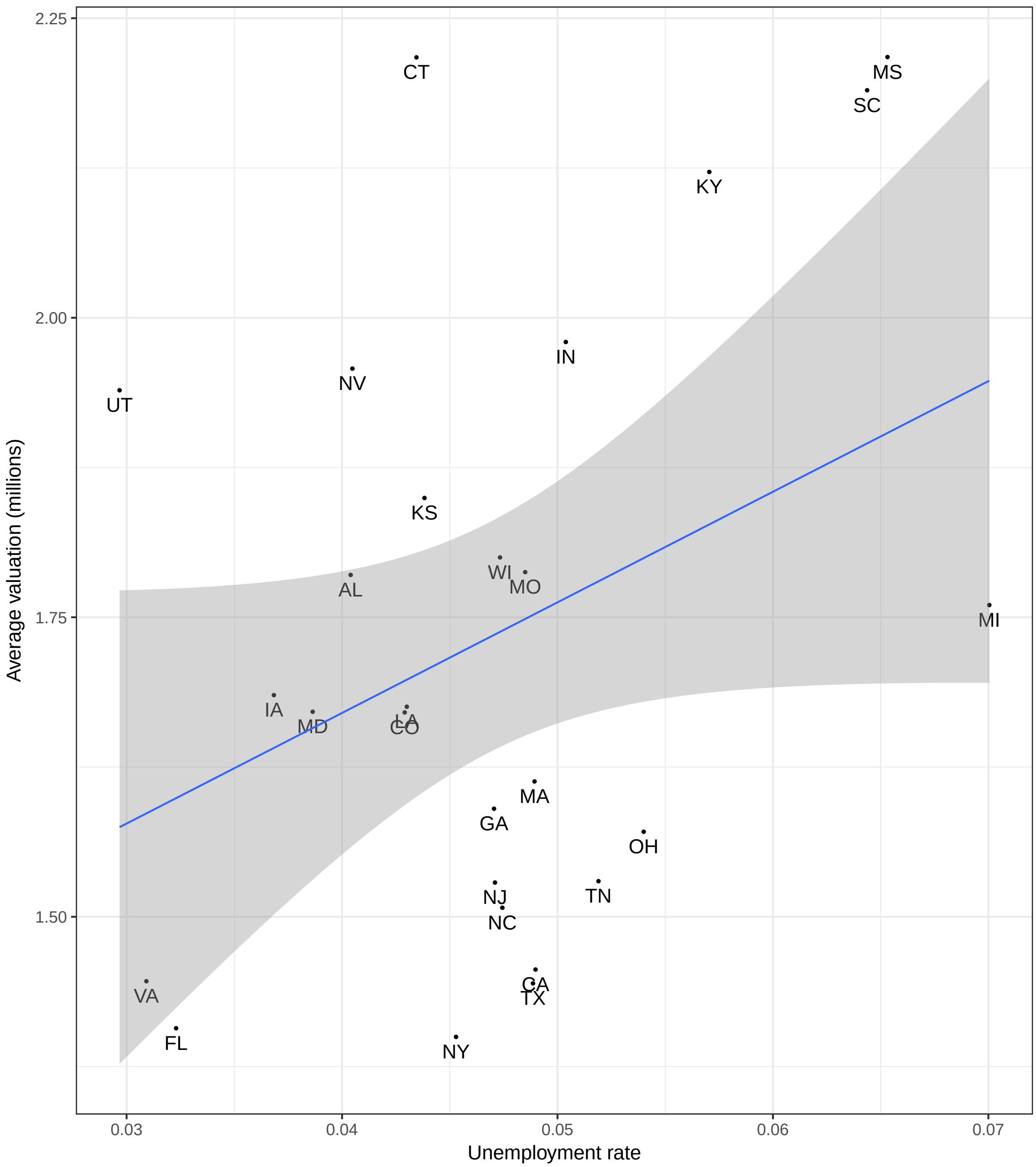
Notes: Upper plot shows the densities of estimated valuations and equilibrium bids. Lower plot shows the equilibrium bid functions; gray dashed line is the 45 degree line. Representative firm is chosen to be a manufacturer headquartered in New York in 2006 with 200 jobs.

Figure 9: Average valuation vs. vote share difference (Dem - Rep)



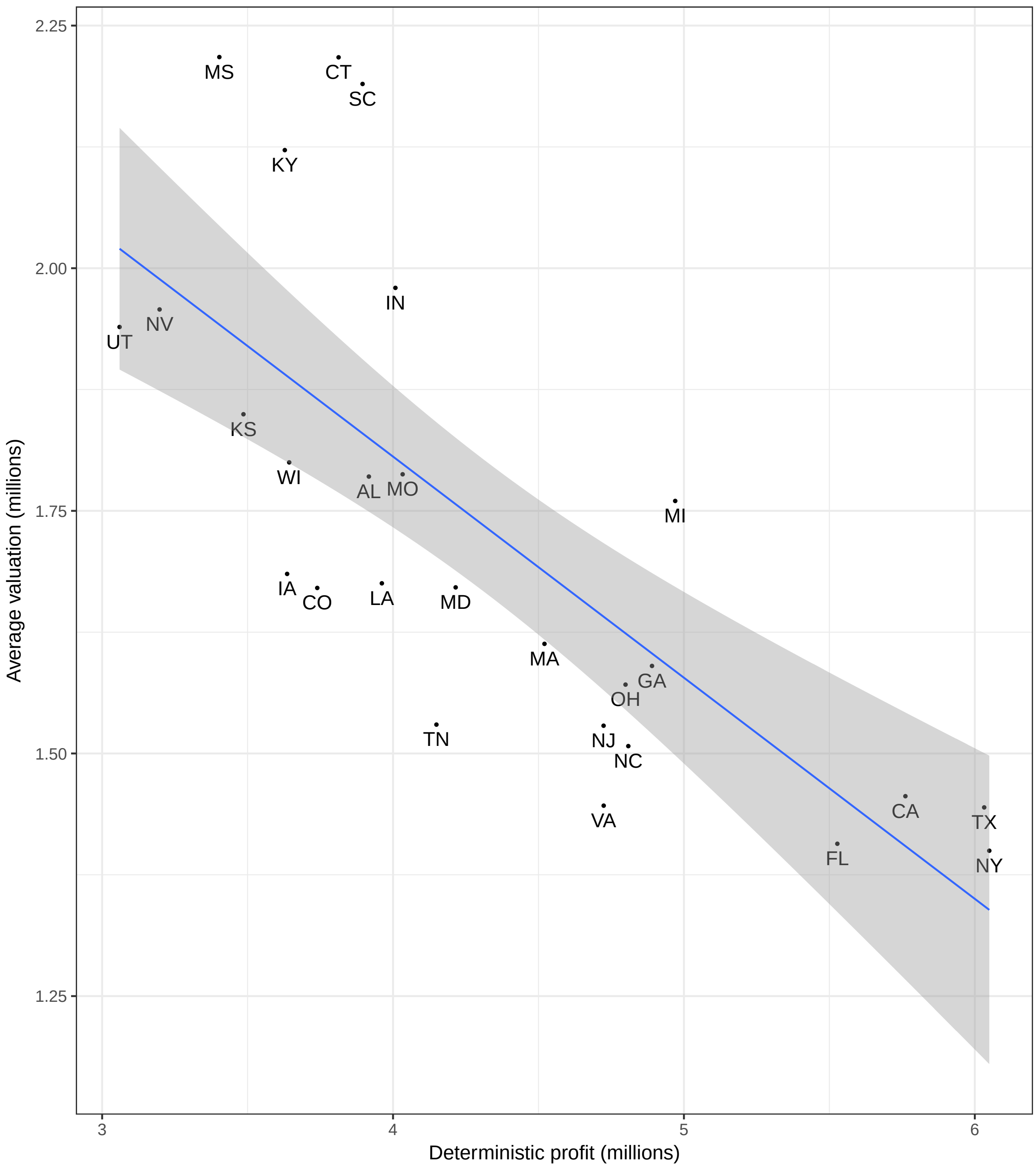
Notes: Representative firm is chosen to be a manufacturer headquartered in New York in 2006 with 200 jobs.

Figure 10: Average valuation vs. unemployment rate



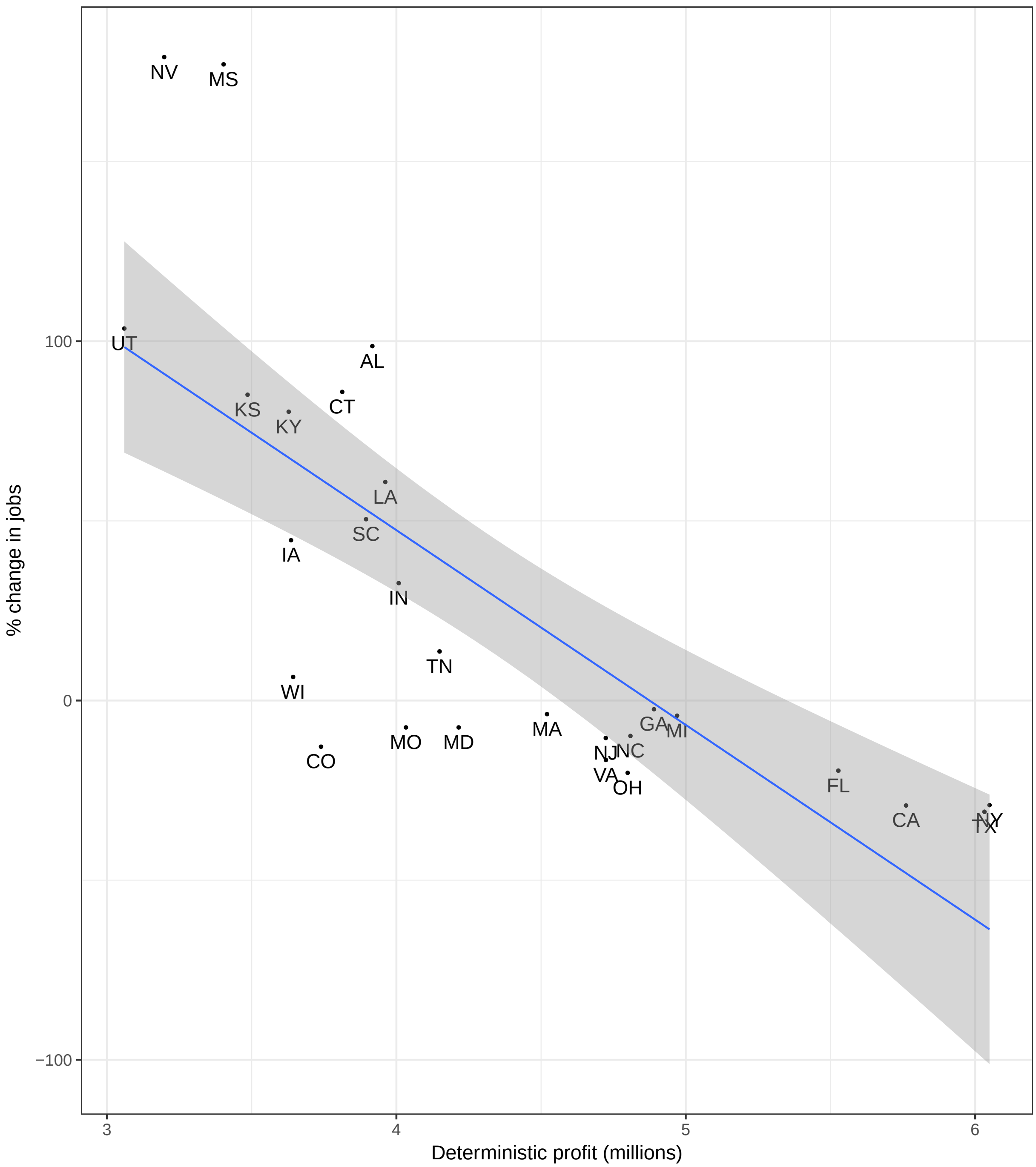
Notes: Representative firm is chosen to be a manufacturer headquartered in New York in 2006 with 200 jobs.

Figure 11: Average valuation vs. deterministic profit



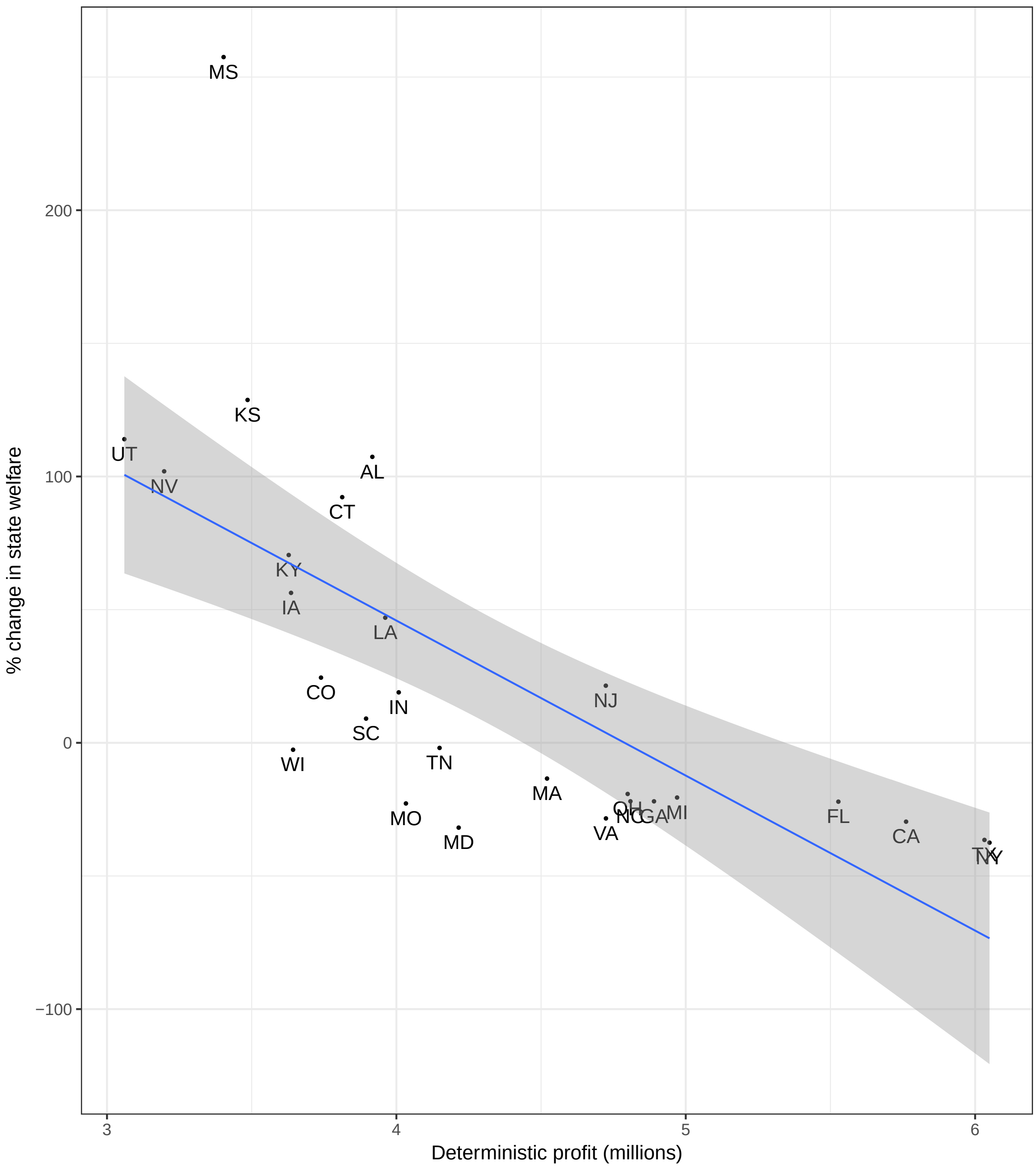
Notes: Representative firm is chosen to be a manufacturer headquartered in New York in 2006 with 200 jobs.

Figure 12: Change in jobs vs. deterministic profit



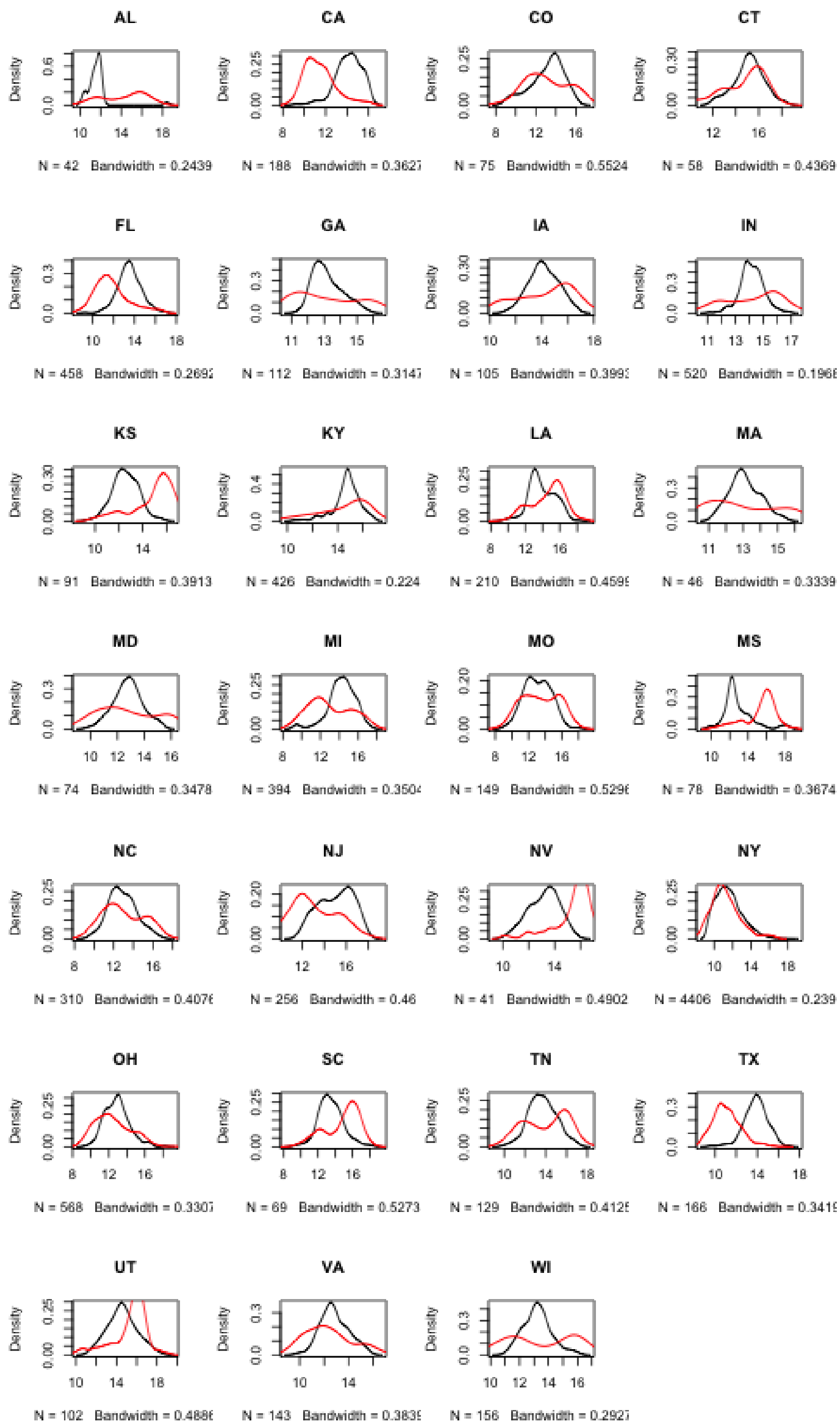
Notes: Deterministic profit is computed using 2006 state attributes.

Figure 13: Change in state welfare vs. deterministic profit



Notes: Deterministic profit is computed using 2006 state attributes. Deadweight loss of taxation is assumed to be 0.25.

Figure 14: Densities of log accepted incentives (data vs. simulated)



Notes: Empirical density is in black, and simulated density is in red.

Appendix

A. Data sources

Appendix Table 1: Data sources

Variable	Years	Source
Incentives and firm characteristics	2000-2017	Good Jobs First Subsidy Tracker
Population	2000-2016	U.S. census
College attainment rate	2005-2016	American Community Survey
Corporate income tax rate	2002-2017	The Council of State Governments
Unemployment rate	2000-2017	Bureau of Labor Statistics
Mean hourly wage	2001-2016	Bureau of Labor Statistics
Gubernatorial election outcomes	2003-2017	The Council of State Governments
Passenger boarding (enplanements)	2016	Federal Aviation Administration
Vehicle-miles of travel	2016	Federal Highway Administration
Waterborne tonnage	2016	US Army Corps of Engineers
Number of manufacturing employees	2016	Annual Survey of Manufacturers
Median monthly housing cost for renter-occupied housing	2016	American Community Survey
Per capita personal income	2000-2017	Bureau of Economic Analysis
Metropolitan Statistical Areas	2010	Bureau of Economic Analysis
Number of establishments	2007-2008	Statistics of U.S. Businesses

B. Sample selection

Raw data from the Good Jobs First Subsidy Tracker (December 2016 version) contains 525,613 observations on incentives provided by federal, state, and local governments. I exclude incentives provided at the federal level and incentives worth less than \$10,000. Sample resulting from these two restrictions is used for Figure 2. I further exclude training and cost reimbursements, and incentives provided to oil refineries. I combine multiple incentives provided to the same firm by same state in same year. With these restrictions, I obtain a sample of 117,300 observations which are used for descriptive analysis in Tables 1 and 2 and Figure 1. In model estimation, I further restrict my sample to incentives worth less than \$0.108 mil per job (99th percentile) provided to firms with jobs $\in [100, 1000]$ after 2005 by states with at least forty observations. With these restrictions, I obtain a sample of 9,372 observations for 27 states.

C. Numerical example in Section 4.5

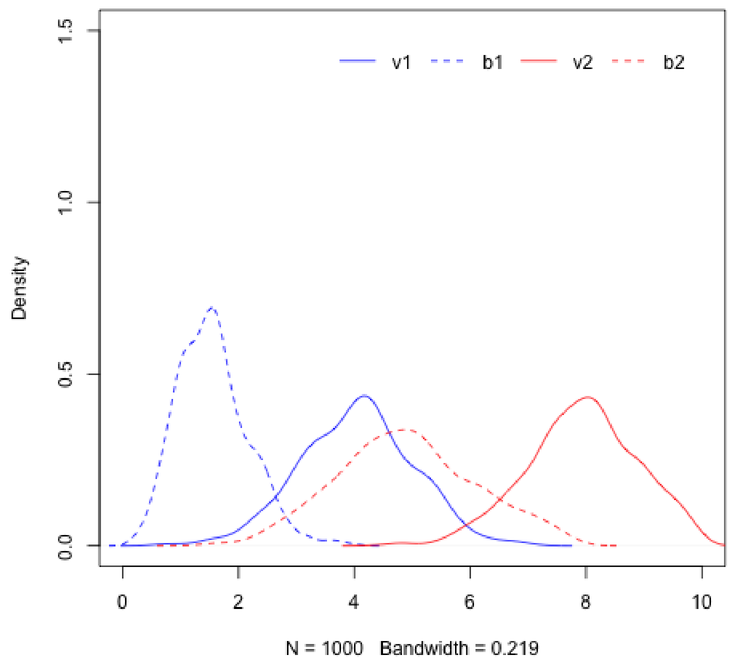
Appendix Table 2: Parameter inputs to numerical example

Simulation	(μ_1, μ_2)	(σ_1, σ_2)	(x_1^π, x_2^π)	β^b
1	$(8, 4)$	$(1, 1)$	$(2, 1)$	$[0.75, 1.25]$
2	$(4, 8)$	$(1, 1)$	$(5, 1)$	$[0.75, 1.25]$
3	$(4, 11)$	$(1, 1)$	$(5, 1)$	$[0.75, 1.25]$

Using parameter values shown in Appendix Table 2, I simulate the model in following steps:

1. For each state ($s = 1, 2$), draw J independent state valuations ($v_1 = (v_{11}, \cdots, v_{J1})$ and $v_2 = (v_{12}, \cdots, v_{J2})$) from truncated normal distributions with parameters (μ, σ) and support $[0, 10]$.
2. Solve for states' equilibrium bid strategies using first-order conditions. I use a quadratic function to approximate equilibrium bid strategies: $b_{j1} = \gamma_0 + \gamma_1 v_{j1} + \gamma_2 (v_{j1})^2$ and $b_{j2} = \delta^0 + \delta_1 v_{j2} + \delta_2 (v_{j2})^2$. As an example, densities of state valuations and equilibrium bids using Simulation 2 parameters with $\beta^b = 1.2$ are shown in Appendix Figure 1.
3. For each firm ($j = 1, \cdots, J$), simulate location choice by drawing iid profit shocks $(\epsilon_{j1}, \epsilon_{j2})$ from Type I Extreme Value distribution and choosing the state that maximizes total profit: $\pi_{js} = x_s^\pi + \beta^b b_{js} + \epsilon_{js}$.

Appendix Figure 1: Densities of state valuations and equilibrium bids in numerical example (Using Simulation 2 parameters with $\beta^b = 1.2$)



D. Equation 6 in Section 5

Fix a state s and firm j and suppress their covariates from the notation. By the definition of conditional probability,

$$\Pr(B < b | s \text{ wins}) = \frac{\Pr(s \text{ wins}, B_s < b)}{\Pr(s \text{ wins})}$$
$$= \frac{\int_{\underline{b}}^{b} w_s(\tilde{b}) g_s(\tilde{b}) d\tilde{b}}{\Pr(s \text{ wins})},$$

where g_s denotes the unconditional density of s's bid. The denominator on the RHS is equal to $\int_{\underline{b}}^{\bar{b}_s} w_s(\tilde{b})g_s(\tilde{b})d\tilde{b}$, but is directly observed. Differentiating with respect to b,

$$g_s(b|s \text{ wins}) = \frac{w_s(b)g_s(b)}{\Pr(s \text{ wins})}$$

so that

$$g_s(b) = \frac{g_s(b|s \text{ wins}) \Pr(s \text{ wins})}{w_s(b)}.$$