Race to the bottom? Local tax break competition and business location*

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Abstract

I analyze how competition between localities affects tax breaks and business location decisions. Using data on firm-specific property tax exemptions, I begin by documenting that spatial competition substantially increases local tax breaks. To do so, I exploit variation in the number of counties near a town, which is correlated with competition but uncorrelated with other observable town characteristics. I then use this pattern to estimate a model of localities competing for mobile firms by offering tax breaks. In counterfactual exercises, I find that policies that reduce competition between localities, such as restricting which levels of government can offer tax breaks, have very little effect on equilibrium firm locations but may lower total exemptions by up to 30%. These findings suggest that local tax breaks primarily lower the taxes paid by mobile firms and are unlikely to substantially affect the efficiency of firm location.

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1 Introduction

Governments in the United States spend approximately $100 billion each year on programs that encourage economic development in a particular geographic area (Kline & Moretti 2014a). These programs, often called place-based policies, typically offer tax breaks in an effort to attract businesses or encourage the expansion of existing businesses. They range from huge subsidies for large factories to policies that target small businesses on a single city block. A crucial feature of place-based policies is their decentralized administration—state and local governments account for 80% of total spending. Since these subnational governments prioritize welfare in their own jurisdictions, strategic interactions may be important for what tax breaks are offered and where businesses locate in equilibrium.

I study two potential effects of decentralization in business tax breaks. First, competition between subnational governments could increase total tax exemptions. Second, local control of tax breaks could lead to more efficient firm locations. The latter may occur if jurisdictions with more to gain from landing a firm offer larger exemptions and thus become more likely to attract the firm. The magnitude of these two effects is important for evaluating policies that restrict which governments can offer tax breaks, such as proposals to ban state exemptions[1] or the recent moratorium on some local exemptions in the greater Phoenix area.

Using data on firm-specific property tax breaks given by towns and counties in New York State, I first document that competition between nearby jurisdictions does indeed increase tax breaks. An additional competitor within 25 kilometers of a town leads to a 20% increase in the probability that some business in that town receives tax exemptions, as well as a substantial increase in the total exemptions businesses in the town receive. In order to study firm location, I then use this pattern to estimate a model of towns and counties competing for mobile firms with tax breaks. In counterfactual exercises, I find that simulated firm locations change very little across three policy regimes, in which towns and counties, only counties, or neither are allowed to offer tax exemptions. About 85% of firms locate in the same town across all three simulations. This suggests that decentralization generates at most small gains in the allocative efficiency of firm location.

[1] See Rolnick and Burstein (1995), Funkhouser (2013), and Badger (2014) for examples.

I begin in Section 2 by broadly describing local economic development programs in the US. Local tax benefits may be quite important to firms, as state and local taxes represent a large portion of the total business tax burden—approximately $688 billion in 2014,[2] compared to total federal corporate income taxes of $320 billion.[3] I then move to my specific setting—Industrial Development Agencies (IDAs), the primary local economic development agents in New York State, and present summary statistics. IDAs offered $660 million of firm-specific exemptions on local property and state sales taxes in 2013. Each of the state's 56 counties has an IDA, which may offer tax breaks to businesses in any town within the county, and 51 towns have established a separate IDA that focuses on their community.[4]

In Section 3, I introduce a simple model of towns offering tax breaks to attract mobile firms. Firms have preferences over locations, but also value tax breaks. Towns choose a tax exemption to maximize their expected value from a firm, which depends on the probability of landing the firm and their social surplus (net of tax exemptions) if they do land the firm. In this framework, competition increases exemptions, and a policy regime that allows towns to offer tax breaks may improve the allocative efficiency of firm location relative to a regime that does not.

Under the restriction that firms consider locations in a constrained geographic area, the model generates the intuitive prediction that towns near more IDAs will have more tax break activity. In Section 4, I test this prediction empirically in order to provide both support for the model assumptions and model-free evidence on the effect of spatial competition. OLS estimates of the relationship between exemptions in a town and the number of nearby IDAs are likely to be biased if a town's decision to establish an IDA is influenced by local economic conditions. For example, if towns that are struggling fiscally are more likely to have an IDA, spatial competition may be correlated with poor economic conditions and associated unobservable characteristics. I use the number of counties near a town as an instrument for the number of nearby IDAs in an attempt to circumvent this problem.

The number of nearby counties is correlated with the number of nearby IDAs both because every county has an IDA and because towns near more counties are empirically more likely

[2] Council on State Taxation, "Total state and local business taxes: State-by-state estimates for 2014."
[3] Office of Management and Budget, Historical Tables; www.whitehouse.gov/omb/budget/Historicals/
[4] New York municipalities may technically be cities, towns, or villages. I refer to all as towns.

to have their own IDA. The validity of the exclusion restriction is less obvious and depends crucially on the inclusion of county fixed effects. With these fixed effects, the identifying variation corresponds to differences in the number of nearby counties across towns within the same county. This is driven mostly by whether a town is in the center, on the edge, or near a corner of its county. This variation appears to be idiosyncratic, as the number of counties near a town is uncorrelated with characteristics such as population, property tax rate, property value, and number of business establishments after conditioning on county fixed effects.

Using this instrument, I find that an additional IDA within 25 kilometers increases the probability that at least one business in a town receives tax exemptions from 25% to 30% and increases the total dollars of exemptions to businesses in the town by over 50%. The effect rapidly fades out as the radius of competition extends beyond 25 kilometers, suggesting that competition is quite local. I also show that the number of IDAs nearby has a larger effect on local property tax exemptions than on state sales tax exemptions or exemptions on other non-local taxes, suggesting that IDAs mainly compete on local taxes.

In Section 5, I parameterize and estimate the model presented in Section 3. The firm profit function follows a Hotelling model—profits in a given town depend on tax rates (net of exemptions) and geographic distance from a preferred location. Because survey evidence suggests that attracting jobs and growing the tax base are priorities for most towns, each town's valuation of a firm is a linear function of the firm's realized property value and full-time equivalent employees. I estimate the model by indirect inference, using the coefficients on IDAs within x kilometers from the IV regressions described above as the matched auxiliary model, for $x = \{25, 30, 35, 40\}$. These regression coefficients show how IDA behavior changes with exogenous shifts in competition and how that effect changes with the distance to competitors—patterns which identify the model parameters.

Parameter estimates from my preferred specification imply that firms are indifferent between a 1.6 mil (.16 percentage point) reduction in their property tax rate and being one kilometer closer to their preferred location. This limits the effect that property tax breaks can have on location. Because the average total property tax rate is about 29 mils, firms cannot be induced to locate more than 18 kilometers from their preferred location, even if they are exempt from all property taxes. Towns value a firm at its assessed property value multiplied by .29, which is roughly ten years of property tax revenue from the project, and its full-time equivalent employment multiplied by $45,000.

Finally, in Section 6, I use the estimated model to simulate two counterfactual policies—eliminating town IDAs and eliminating all IDAs. Focusing first on firm location, I find that firms typically choose the same location across the two counterfactuals and a status quo simulation, limiting the size of potential allocative efficiency gains. The town most likely to land a particular firm is the same in every policy regime for about 85% of firms. This result occurs not only because firms are relatively inelastic to tax breaks, but also because of equilibrium IDA interactions. For example, suppose that Syracuse is attractive to Firm A and has a very high probability of winning when no tax breaks are allowed. When local tax breaks are allowed, competing towns will offer tax breaks in an attempt to cut into Syracuse's lead. However, if those towns become too much of a threat, Syracuse will then offer an exemption large enough to stay ahead of the competition and maintain a high probability of landing Firm A. This strategic behavior reduces changes in firm location across policy regimes. Turning to total tax breaks, I find that eliminating the 51 town IDAs would lower exemptions by about 30% by decreasing the number of competitors for the average firm, while a ban on tax breaks obviously reduces the total amount of exemptions to 0.

While the baseline model imposes a common value for a firm across towns, I allow heterogeneity in valuations across towns with different poverty rates in an extension. I find that firm movement across counterfactuals remains quite low and that the improvements in allocative efficiency from decentralization are trivial relative to the associated increase in tax breaks. The average town surplus from a firm is approximately $50,000 higher when all IDA are active than under the exemption ban, while the average total exemption increases by over $1,000,000. An important caveat to this extension is that heterogeneity in valuation across towns is hard to predict, and poverty is only one of many possible parameterizations.

In order to clarify the patterns in the data that drive my results, it is helpful to consider what alternative parameter values would lead to more firm movement across counterfactuals. Had I estimated that tax exemptions were more important to firms, there would have been much more firm movement across policy simulations. For example, when tax breaks are more powerful, the town IDAs included in the status quo regime are able to greatly alter firm location relative to the exemption ban or county IDA regimes. However, these alternative parameter values do not match key moments in the data. In particular, if tax exemptions were so important, IDAs from further away would be able to exert competitive pressure, and the observed coefficients on the number of IDAs in 35km and IDAs in 40km in the IV competition regressions would be much larger. These regression coefficients thus help drive the result that firm location is very similar across policy regimes.

An important caveat to my results is that the model is best suited to firms that are relatively spatially constrained in their location choices, such as retail and services establishments, distribution centers, or small local manufacturing ventures. In the body of the paper, I show that businesses in my sample tend to be relatively small and are frequently in the retail and services sectors, suggesting that they are likely geographically constrained. I also present survey evidence suggesting that many firms search within a local area. However, several issues could arise if many firms conduct national or statewide searches. In this case, the model would be misspecified, as important bidders and elements of the firm choice set would not be included. I would additionally face a selection problem, as I would not observe the firms that bargained with IDAs and subsequently did not locate in the state. This would cause my reduced form results to be biased towards the effect of competition for firms conducting only a local search. In an extension where this issue may be less concerning, I estimate the model on a sample of only retail and services firms and find counterfactual results very similar to the full sample estimates.

This paper is most closely related to the literature on firm-specific tax breaks, which has pointed to both the effect of competition on exemptions and various channels through which decentralization could improve allocative efficiency. I build on the prior literature by empirically testing theoretical predictions about efficiency, by attempting to identify the causal effect of competition on exemptions, and by simulating how policies reducing competition would affect tax breaks.

Several theory papers highlight the potential allocative efficiency gains from firm-specific tax exemptions, including Black & Hoyt (1989), Bartik (1991), Garcia-Milá & McGuire (2001), and Fumigalli (2003). Additionally, Martin (2000) and Menezes (2003) make this point by applying auction models with heterogeneous town valuations of firms, a framework similar to this paper. Turning to the effect of competition, Martin (2000) derives a positive relationship between the number of jurisdictions competing for a firm and expected tax breaks, while Holmes (1995) shows that a ban on state tax breaks could be welfare-improving. The previous empirical evidence on local competition and firm-specific tax breaks—which includes Anderson & Wassmer (1994), Edmiston & Turnbull (2003), and Cassell & Turner (2010)—documents a positive correlation but has not identified a causal relationship. Similarly, Felix & Hines (2013) find that localities near a state border are significantly more likely to offer tax breaks, likely because of increased competition.[5]

Perhaps the most closely related paper conceptually is Ossa (2015), who considers tax break competition between states using aggregate data and a macro/trade framework and finds that tax breaks significantly distort manufacturing output. While we ask similar questions, my study differs from his in several ways. I use micro data, model individual firm decisions, and primarily consider local competition. In contrast to his findings of relatively large distortions from state tax breaks, I find at most small changes in efficiency from local tax breaks. This difference could result either from different methodological approaches or from differences between the local and state settings.

While I focus largely on the government decision to offer tax breaks, I also consider how tax rates affect firm location. A full review of this literature is beyond the scope of this paper, but several recent papers, including Giroud & Rauh (2016), Suárez Serrato & Zidar (2016), Chirinko & Wilson (2008), and Moretti & Wilson (2016), suggest that firm locations are responsive to state tax rates, typically finding elasticities within the -.1 to -.6 range suggested by Bartik & Erickcek (2014). A natural followup question is how subnational taxes distort firm locations, and Fajgelbaum et al. (2016) use a trade framework to find the potential for substantial efficiency gains from tax equalization across states. Firm location within a metropolitan area has been studied somewhat less frequently, but estimates of the elasticity

[5]More broadly, there is a rich literature on fiscal federalism and intergovernmental tax competition. This literature typically considers base tax rates with homogeneous firms and towns, rather than specific tax breaks from heterogeneous towns to heterogeneous firms. Many theoretical papers, reviewed in Wilson (1999), have considered tax competition under a variety of frameworks and have come to diverse conclusions about whether it leads to efficient outcomes. Economists have also empirically studied competition in base sales and property tax rates, as reviewed in Brueckner (2003), Agrawal et al. (2014), and Revelli (2015).

of labor demand to local property taxes are substantially larger—approximately -2 (Bartik (1991), Wasylenko (1999)). I contribute to this literature first by using a novel identification strategy to find an intra-regional elasticity of business establishments to property taxes of approximately -3. I also consider how local tax breaks affect efficiency, finding that, although firms are elastic to tax exemptions, equilibrium interactions between localities typically prevent tax breaks from changing firm locations, resulting in minimal efficiency changes.

Finally, this paper contributes to the literature on place-based policies, which includes Kline & Moretti (2014b), Busso et al. (2013), and Greenstone et al. (2010). This literature has typically evaluated the effect of specific policies on local and national employment, productivity, and welfare, whereas I focus on the implications of the decentralized administration of these programs. Differences in administration, and how they affect the government decision to offer tax breaks or subsidies, are potentially important for understanding why some place-based policies lead to different outcomes than others.

2 Setting and Data

2.1 Local economic development and tax breaks in the US

Governments across the US care deeply about local economic development and employ a variety of strategies to attract and retain firms. In surveys conducted by the International City/County Management Association, local governments most frequently list attracting jobs, increasing tax revenue, and improving quality of life as their primary development goals. To pursue these goals, they provide not only tax breaks, but also infrastructure improvements, expedited permitting, utility rate reductions, specialized job training programs, and reduced interest financing. Some local governments handle economic development in house, while others are represented by nonprofit economic development corporations.

Anecdotally, competition between governments is a strong force in economic development decisions. In the 2014 wave of the ICMA survey, 60% of responding governments reported strong competition in their region. The 2009 wave of the survey suggests that a substantial portion of this competition comes from neighboring localities, as 80% of respondents stated that nearby municipalities were competitors, while only 50% said they faced competition from other states and 20%, other countries. Similarly, Kayser and Goetz (1993) survey municipalities in the Minneapolis-St. Paul region and find that they most frequently list immediate neighbors as their strongest competitors.

Firms form the other half of the economic development picture. *Site Selection*, a corporate real estate magazine, surveys firms and site selection consultants annually on the factors most important to location decisions.[6] Tax breaks and business climate consistently make the list, but three other factors typically rank ahead: local labor force, transit connections, and proximity to customers and existing operations. One executive referred to tax breaks as a tie-breaker, while another referred to them as "icing on the cake." The reports suggest that while tax breaks can sway firm decisions, they do not outweigh factors crucial to operations.

In this paper, I primarily study exemptions on local property taxes, which are a substantial proportion of firms' total tax burden. According to a report from the Council on State Taxation, businesses paid $250 billion in property taxes in 2014, which accounted for 36% of the total $688 billion they paid in state and local taxes. For comparison, the Office of Management and Budget estimated that federal corporate income taxes totaled $320 billion in 2014.[7]

2.2 New York Industrial Development Agencies

I study local economic development in New York State, focusing on the tax breaks offered by Industrial Development Agencies (IDAs). IDAs are local economic development agencies that represent either counties or towns and may offer a variety of tax exemptions to achieve their goal of "[improving] economic conditions in their respective areas." There were 107 IDAs active in 2013, composed of 51 representing towns and 56 representing counties.[8]

These agencies have a complex set of objectives and may play different roles in different communities. Apart from common goals like creating jobs and growing the tax base, they

[6] Surveys may be found in the January issues of *Site Selection*; http://siteselection.com/pastissu.cfm

[7] OMB, Historical Tables: Table 2.1; http://www.whitehouse.gov/omb/budget/Historicals/

[8] There were additionally two IDAs that either gave no exemptions or did not report data to the state comptroller from 2010-2013. I classify these IDAs as inactive. My results are not sensitive to this exclusion.

are anecdotally concerned with everything from attracting better shopping options to a rural area to bringing business back to an old industrial park. IDAs support a diverse array of projects, ranging from the large Beech-Nut baby food plant in Amsterdam to the Premier Liquor and Wines outlet in Amherst. A government-appointed board of 3-7 people, typically community business owners or local government officials, manages each IDA. Agencies must hold a public hearing before offering tax breaks but otherwise face few restrictions.

IDAs make firm-specific agreements—the Beech-Nut plant may receive quite a different package than the liquor and wine outlet—and may offer several types of tax breaks. They can exempt some or all of a business's property tax liability for each jurisdiction—municipal, county, and school—collecting property taxes in New York State. These are usually the largest exemptions and are typically issued in 7-15 year schedules. For example, a company may pay 50% of its property tax liability in the first year of agreement and then gradually see exemptions fade out over the next nine years. IDAs may additionally exempt state and local sales taxes on a company's purchases, as well as a one-time county mortgage recording tax (equal to about 1% of a property's value).

Each town has the ability to establish an IDA or to dissolve their existing IDA, making agency location endogenous to economic and political conditions. If a town does not have its own IDA, it is represented by its county IDA, which may exempt taxes for businesses in any town within its borders. Interviews suggest that county IDAs generally only offer exemptions in towns that do not have their own IDA. While county IDAs are spread evenly throughout the state, with one in each county, town agencies cluster in metropolitan areas, especially around Buffalo and Albany. IDA locations in 2013 are shown in Figure 1.

In 2013, IDAs supported 4,709 projects with a total property value of $76.8 billion. Approximately one percent of existing establishments received IDA exemptions in that year, totaling $660 million.[9] This is roughly $34 of exemptions per capita. I present more detailed summary statistics in Sections 2.4 and 2.5. Section 1 of the Appendix provides more details on IDAs and their legal powers.

[9] These figures represent the annual exemptions on all agreements active in 2013, i.e. $\sum_i (tax\_liability\_2013_i - tax\_paid\_2013_i)$, not the total exemptions over multi-year agreements.

2.3 Data sources

The Office of the New York State Comptroller publishes detailed annual information on every IDA tax exemption agreement, and these releases serve as my primary data source on IDA activity. For each agreement active in a given year, this data includes the name of the company operating the project and the total tax liability and exemptions in that year for municipal, county, and school property taxes; local and state sales taxes; and the mortgage recording tax. For example, in the 2013 data, the reader can see that the Beech-Nut factory received about $3.25M in exemptions (all on property taxes) in that year.

The data also includes sector of the project, the number of full-time equivalent employees at the site, the address of the project, the date the project was approved, and the date exemptions will end. The Comptroller has released this data set annually from 2008 to the present.

I bring in several additional data sources to construct detailed characteristics of each town. I generate demographic information using the 2006-2010 American Community Survey. I take information on the number of establishments in each jurisdiction from the ReferenceUSA database, which aims to provide the address and sector for the universe of US business establishments. I compute an average total property tax rate for each town using the New York State Comptroller's Overlapping Real Property Tax Tables, and the Comptroller also publishes data on municipal revenue, expenditure, and total assessed property value. Finally, data on other programs offering tax breaks in New York was taken from the Good Jobs First's Subsidy Tracker 2.0 database. A much more detailed description of the data construction can be found in Section 2 of the Appendix.

2.4 Key variables

a. IDA tax exemptions: Throughout the paper, I restrict analysis to the subset of IDA agreements involving private, for-profit companies. I also drop agreements classified as Agriculture/Forest/Fishery or Transportation/Communication/Electric, reasoning that these are unlikely to be mobile firms. This leaves 2,649 agreements which received $479 million in exemptions in 2013.

Agreement-level summary statistics, shown in Panel A of Table 1, show a heavy right skew across projects in the total dollars of taxes exempted in 2013. The median, 75th percentile, and 95th percentile are respectively \$28,100, \$92,400, and \$590,000. Note that these figures represent an annual flow, while the total tax break is dispersed over multiple years. Over ninety percent of agreements active in 2013 began in 1999 or later, indicating that very few IDA agreements last over 15 years.

Because I run some of my analysis at the town level, I collapse the data from the agreement level to the town level in Panel B of Table 1. There is again a heavy right skew in the dollars of taxes exempted in 2013, with the median town having no businesses receiving exemptions and the 95th percentile town containing businesses receiving over \$1,600,000 in exemptions. About 36% of towns have at least one business receiving exemptions. The mean percent of establishments receiving exemptions is .4%.

b. Agreement sector and employment: IDAs differentially subsidize firms across sectors—about 34% of active agreements in 2013 were to manufacturing (e.g. McIntosh Box, Beechnut Baby Food), 14% to retail (Costco, Gigglin' Pig Furniture Superstore), 11% to finance/corporate office (Melville Corporate Center), and 41% to services (Gold's Gym, Glen Storage). However, a higher percentage of new manufacturing establishments between 2006-2011 received exemptions (about 2%) than did retail, services, or finance establishments (about 0.5-1%).

Panel A of Table 1 contains statistics on the self-reported number of full-time equivalent employees at each project. The median project has 40 FTE employees, and the 95th percentile has about 520. An example of the median project is a midsize retail establishment such as the previously mentioned liquor outlet, while the Wal-Mart distribution center in Sharon Springs has close to the 95th percentile employment.

c. Competition measure: My primary measure of spatial competition, the number of IDAs within 25 kilometers of a town, is shown in Panel B of Table 1 and varies from 0 to 15. However, most of the sample lies between one and eight. The number of counties within 25 kilometers, which I will use to instrument for the number of proximate IDAs, varies from zero to five. Distances between towns were computed as the distance between geographic centroids, while the distance between a town and a county was taken as the distance between the centroid of the town and the centroid of the closest town in the county.

2.5 Descriptive Statistics

Before moving to the analysis of strategic interactions between agencies, I present two descriptive exercises to provide a richer picture of IDAs. I first examine which towns tend to charter IDAs. This is important for understanding how areas with many IDAs are different from other areas and in what conditions towns think having an IDA is useful. In Table 2, I compare characteristics of towns with and without their own IDA.[10] The two samples are quite different—towns with an IDA are larger, poorer, and have more IDAs within 25km. These results may suggest that town IDAs are more likely to form in urban areas, perhaps because a larger flow of economic activity increases the returns to an agency. They are also consistent with poor, struggling towns establishing an IDA to help attract business, a story that fits with the large number of IDAs in western New York.

Second, I show some simple graphical evidence on the relationship between the number of nearby IDAs and the dollars of exemptions in a town. In Figure 2, each stacked bar represents the set of towns with a given number of IDAs within 25 kilometers. The bars are colored according to what percent of towns in that set gave a given amount of tax breaks in 2013. The composition of bars changes markedly as the number of nearby IDAs increases, with more towns giving large amounts of tax breaks. This pattern suggests that competition may increase exemptions, but does not account for the endogenous location of IDAs.

3 Model

3.1 Framework

I begin by describing a simple model of towns competing to attract mobile firms with tax breaks. I test a model implication in Section 4 and parameterize and estimate the model in Section 5. The framework is similar to a first-price scoring auction and also has some features in common with Greenstone and Moretti (2004)

[10]To avoid skewing means, I do not include New York City in the sample.

Firm f receives profit

$$\pi_{fk} = \alpha_{fk} + b_{fk} + \epsilon_{fk} \tag{1}$$

from locating in town k, where α_{fk} is observable and depends on town characteristics including the base tax rate, b_{fk} is a tax break offer, and ϵ_{fk} is an unobservable error term. In my empirical application, α_{fk} depends on distance from a preferred location, making firm preferences (and competition between towns) spatially concentrated. I later discuss in detail why this structure may be appropriate for my setting.

Town k receives value V_{fk} equal to v_{fk} if it lands the firm and 0 otherwise. Towns observe α_{fk} and play a Bayesian Nash equilibrium in b_{fk}. The firm locates in the town k^* that maximizes profit and receives the tax break offer b_{fk^*}.

Towns choose their tax break offer b_{fk} to maximize their expected value from a firm:

$$E(V_{fk}|b_{fk}, b_{f(-k)}) = P(win_{fk}|b_{fk}, b_{f(-k)}) * (v_{fk} - b_{fk}) \tag{2}$$

where $P(win_{fk}|b_{fk}, b_{f(-k)}) = P(\pi_{fk} > \pi_{fj} \; \forall \; j \neq k|b_{fk}, b_{f(-k)})$. Towns face a tradeoff analogous to many pricing models—offering a larger exemption increases the chance of attracting the firm, but decreases the benefit in the event the firm does locate in the town.

3.2 Competition and efficiency effects

Town k's first-order condition can be written as:

$$b^*_{fk} = v_{fk} - \frac{P(win_{fk}|b_{fk}, b_{f(-k)})}{P_b(win_{fk}|b_{fk}, b_{f(-k)})}$$

where P_b is the derivative with respect to b_{fk}. Note that because P_b is positive, the maximum exemption a town will offer is v_{fk}. The second term acts somewhat like a markup term in many IO models. An oligopolist charges a higher price when there are fewer competitors, while in this setting a town offers a smaller exemption as its probability of winning increases (all else equal). Lastly, when taxes are more powerful at changing firm location, P_b is larger and towns offer larger tax breaks.

The key tradeoffs of local tax breaks can be seen in this first-order condition. Focusing first on the efficiency effect, note that an omniscient social planner would allocate firm f to the town with the highest value v_{fj} (supposing either that differences in firm profits across locations are small or do not enter the planner's objective). While there is no such planner, local tax breaks may lead to a set of firm locations closer to this optimum than a regime with no local exemptions. To see this, note that if a town's bid currently satisfies the first-order condition and v_{fj} increases, the optimal bid will also increase. Higher valuation towns will thus bid more and be more likely to land the firm.

The competition effect is also apparent in the first-order condition. If a town's bid currently satisfies this equality and an additional competitor is added, P(win) will decrease, and in order to restore the equality, the town must increase its bid.

3.3 How tax breaks can change business location

Figure 3 helps illustrate how tax breaks may change a firm's location in this model by plotting the decision faced by a hypothetical firm. Panel A represents the firm's decision when towns are not allowed to offer tax breaks, and Panel B represents the decision when tax breaks are allowed. The bars for each town depict its total attractiveness to the firm. The solid portion of the bar (α in Equation 1) represents the attractiveness of the town's characteristics including the base tax rate, the hollow portion of the bar (b) represents the tax break offered by the town, and the hashed portion of the bar (ϵ) represents the firm's unobservable preference for the town. Note that because of the unobserved portion of firm utility and the heterogeneity in town valuations, the most attractive town will not simply outbid the second most attractive by one dollar.

In the example in the figure, introducing tax breaks does not change the firm's decision. The town of Amherst, which is most attractive to the firm in the absence of tax breaks, remains the most attractive when tax breaks are allowed. It offers a small tax break in order to maintain that position.

However, there are several situations in which introducing tax breaks could change a firm's location decision. First, heterogeneity in town valuations of a firm could lead to the town of Buffalo offering a tax exemption that Amherst is unwilling to match. Second, there may be distortions from base tax rates. It may be that a firm prefers Buffalo to Amherst, but Buffalo has a higher base tax rate. If both towns exempt all of their taxes, the firm will switch from Amherst to Buffalo. Third, note that although Amherst remains the most attractive in the example in Figure 3, the other town's tax breaks may have increased their probability of winning in the event that the firm drew a new error term.

Finally, in the New York setting that I study empirically, there is an intermediate stage between town tax breaks and no tax breaks—allowing counties to offer tax breaks. I model each county as a cartel of towns, and moving from county tax breaks to town tax breaks can change firm locations by splitting up cartels.

The estimated parameters of this model will affect how often each of these scenarios occur and hence how many changes in firm location are observed. If the estimates imply large heterogeneity in town valuation, this could lead to many changes in firm location. If taxes are very important to firms, the distortions from initial tax rates and the effect of breaking up cartels would be large. Finally, if the error term in firm profit is large, it may be that competing towns can carve out a relatively large probability of landing the firm, even if they never become the most attractive town in the observable component of firm profit.

This model imposes a strong structure on the data. In my parameterization in Section 5, I will further assume that firm preferences over towns are a function of distance from a preferred location. Before estimating the model, I first provide some support for these assumptions by showing that the data is consistent with an intuitive model implication about spatial competition: towns near more IDAs should, all else equal, have more tax breaks.[11] This trend also provides model-free evidence on the effect of spatial competition on firm-specific tax breaks.

[11] Martin (2000) proves in a very similar model that more bidders lead to a higher expected tax break for a firm. I test a similar implication at the town level in order to take advantage of areas where no firms received tax breaks. The extension from the firm level to the town level follows immediately from properties of the expected value. In my setting, the number of nearby IDAs is equivalent to the number of bidders.

4 Reduced Form Evidence on Spatial Competition

4.1 Empirical strategy

I now study the model implication that there will be more tax breaks in towns near more IDAs. In my baseline specification, the sample is the 1096 towns[12] in New York State, an observation is one of those towns in 2013, and errors are clustered at the county level. The model for outcome Y in town i and county k is

$$Y_i = \gamma * \#(IDAs\, in\, 25\, km)_i + \delta * X_i + \alpha_k + \epsilon_i \tag{3}$$

where α_k is a county fixed effect and X_j is a large vector of town characteristics. Y_i is either the log total exemptions to businesses in town j or an indicator for whether any business in j received exemptions. γ, the relationship between an additional competitor and tax break activity in a town, is the coefficient of interest.

X_i includes variables related to population, business activity, demographics, and geography. The population variables are total population, population squared, population within 25 kilometers, and population within 25 kilometers squared. Business activity measures include establishments, establishments squared, establishments within 25 kilometers, and establishments within 25 kilometers squared. Geography variables are the number of cities in 25 kilometers and an indicator for being within 25 kilometers of the state border. Finally, demographic variables are percent of households in poverty, percent of individuals who are white, percent of individuals who are college-educated, and percentage of workers in manufacturing, services, and business sectors. I also report results for subsets of X.

OLS estimates of Equation 3 are likely to be biased. Towns choose whether or not to charter an IDA, making the number of IDAs in an area endogenous. There is some evidence that towns that are struggling economically are more likely to establish an IDA (as in Table 2 and Felix & Hines (2013)), leading to a correlation between number of IDAs

[12] New York municipalities may technically be cities, towns, or villages. For simplicity, I refer to them all as towns. Villages are subsets of towns or cities. I include only a few large villages, those with over 1,000 residents, as separate observations and collapse the remainder into their containing town or city.

and the unobservable characteristics of poor local economies. This correlation could bias the estimated effect of competition downwards, as struggling areas likely have a relatively low flow of arriving firms. This would depress total tax breaks in these areas even if IDAs competed aggressively, as there would simply be fewer firms to give tax breaks. Alternatively, IDAs in struggling areas may be particularly desperate for development and offer large tax breaks independent of competition, biasing estimates upward. My results are more consistent with the first story.

In an attempt to isolate exogenous variation in spatial competition, I use the number of counties within 25 kilometers as an instrument for the number of IDAs within 25 kilometers. This instrument is obviously correlated with the number of nearby county IDAs and, because towns near more counties are more likely to have their own IDA, is also correlated with the number of nearby town IDAs.[13]

The argument for the exclusion restriction is less obvious. As one might expect, counties are generally smaller in more populated urban areas, causing towns in these areas to be near more counties. Moreover, towns near borders formed by rivers will be both near more counties and potentially able to take advantage of the river for shipping or manufacturing. The validity of this restriction depends crucially on the inclusion of county fixed effects. With these fixed effects, the identifying variation actually corresponds to the number of counties near a town relative to other towns within the same county. This variation is driven mostly by whether a town is in the center, on the edge, or near a corner of the county, as shown in Figure 4, which plots the number of counties within 25 kilometers of each town in Ulster County. Appendix Figure 1 expands on this by showing the number of counties within 25 kilometers for each town in the state, both in the raw data and demeaned at the county level. While the number of counties is higher around population centers before demeaning, the map shows no clear pattern after removing the county-level mean.

A balancing test, presented in Table 3, suggests that this variation is indeed idiosyncratic. After controlling for county fixed effects, the number of counties near a town is uncorrelated with key observable town characteristics such as business establishment counts, population,

[13]The first-stage relationship is strong, with an F-statistic of 93. An additional nearby county is associated with an additional 1.12 (SE: 0.039) nearby IDAs.

population within 25 kilometers, base property tax rates, and median home value. Moreover, a regression of the instrument on all of the variables reported in Table 3 and a vector of county fixed effects yields a small, statistically insignificant F-statistic of 1.36.

4.2 Results

Results are shown in Table 4. Panel A shows probit and IV probit estimates of Equation 3 with an indicator for whether a town contains any businesses receiving IDA exemptions as the dependent variable. The regular probit specification in Column 5 shows a strong and statistically significant correlation. The coefficient of .17 implies that an additional IDA within 25 kilometers is associated with a 5.7 percentage point increase in the probability that a town contains at least one business receiving exemptions. In Columns 1-4, I instrument for nearby IDAs with nearby counties and include various sets of fixed effects and control variables. The coefficient on nearby IDAs is always positive and statistically significant and is larger when including county fixed effects and geographic controls. In Column 4, the specification with county fixed effects and the full set of control variables, an additional nearby IDA increases the probability by 5.7 percentage points, from 24.8 to 30.5% at the median predicted probit score.

Panel B shows OLS and IV specifications with log total exemptions as the dependent variable. The OLS specification in Column 5 shows that an additional IDA is associated with about a 43% increase in exemptions. Columns 1-4 show results from IV specifications with different sets of fixed effects and control variables. In Column 4, again the preferred specification, the coefficient on nearby IDAs is .522.

While these effect sizes are large, note that an additional IDA represents a large increase in competition—the median town has only three IDAs within 25 kilometers. On the whole, these results suggest that spatial competition has a substantial effect on the tax breaks IDAs offer, in line with the proposed model's implications. Surprisingly, the dummy for being with 25 kilometers of a state border is not statistically significant, suggesting that competition from bordering states may not be crucial for the tax breaks offered.

In Table 5, I vary the radius on both the nearby IDA measure and nearby county instrument from the base of 25 kilometers to 20, 30, 35, or 40 kilometers. The coefficient on the

IDA measure is quite similar at 20 and 25 kilometers, but shrinks rapidly as the radius increases above 25, disappearing completely at 40 kilometers. This suggests that competition is very local, which will help to identify structural parameters of the model.

4.3 Heterogeneity by taxing body

IDAs may exempt taxes collected by municipal, school, county, and state governments. Since some of these taxes go directly to local services, while others enter a much larger budget with a more nebulous connection to local quality of life, IDAs may perceive different costs for different types of exemptions. This could lead to heterogeneous effects of competition on different types of tax breaks. For example, if IDAs see a lower cost to offering state exemptions and thus meet firm requests regardless of competition, the association between state exemptions and competition will be relatively weak.[14]

I examine this heterogeneity first by estimating the main IV specification separately with dependent variables of municipal, school, county, and state tax exemptions. Results are shown in the Columns 1-4 of Table 6. The coefficient on nearby IDAs is roughly twice as large for town exemptions as for state exemptions. This could occur because IDAs see a lower cost to offering state exemptions, but the difference in magnitudes could also be caused by differences in the amount of state versus local exemptions requested or the industries that are more likely to request state exemptions. However, the first story is anecdotally supported in the tax exemption guidelines that IDAs are required to post online. While IDAs consistently leave considerable discretion in the property tax exemptions they can offer, most state that all projects approved for property tax exemptions will also receive their requested sales tax exemptions.

Second, I consider New York State's Empire Zone program, which provides firms with credits on state taxes.[15] In Column 5 of Table 6, I run the main IV probit specification with an indicator for whether a town has an Empire Zone as the dependent variable and find a small and insignificant effect. This is again consistent with competition having a relatively small effect on exemptions which have a low local cost. Moreover, it suggests that state

[14]There is some anecdotal evidence that IDAs prefer to exempt state taxes rather than local taxes.
[15]Empire Zones are not necessarily administered by IDAs. I provide some program details in the Appendix.

programs may not be a major dimension of competition between IDAs.

4.4 Robustness

I report several robustness checks in Appendix Tables 1 to 5. In Appendix Table 1, I selectively drop areas of the state from the sample and rerun the main specification of Equation 3. Note that because New York City is the only town in its county fixed effect, it is already effectively dropped from the regressions reported above. I separately drop the greater New York City area, the Buffalo area, the Albany area, and the sparsely populated area north of Albany. The estimates remain relatively consistent across samples, suggesting that neither major metropolitan areas nor the rural area in far upstate New York are driving results.

In Appendix Table 2, I consider a number of alternative specifications for the results reported in Table 4. Column 1 repeats the specification in Column 4 of Panel A of Table 4, but uses a linear probability model rather than a probit. The linear specification avoids the incidental parameters problem and returns an estimate of .045 for the coefficient on nearby IDAs, which is very similar to the marginal effect in the IV probit estimation. In Column 2, I estimate a tobit model in order to account for the large mass of towns with no exemptions and find a large and statistically significant positive effect of competition. Column 3 uses the inverse hyperbolic sine of exemptions as the dependent variable, rather than the log of exemption plus one, and yields a cofficient of .57. This is very close to the baseline estimate of .52 from Column 4 of Panel B of Table 4. Finally, in Column 4, I use the percent of establishment receiving tax breaks as the dependent variable. I drop establishment count variables from the set of controls in order to avoid division bias. This specification yields a statistically significant coefficient of .001 on nearby IDAs, indicating that an additional IDA increases the percent of establishments receiving exemptions by about .1%. This is a large effect, as the mean percent of establishments receiving exemptions in a town is .4%.

In Appendix Table 3, I study competition from very short distances. Because the variation in the number of nearby counties decreases as the radius on the competition measure shrinks below 20 kilometers, I consider OLS estimates rather than IV and report results with and without county fixed effects. Although these estimates are likely affected by the endogeneity of the competition measure, changes as the radius shrinks may still be informative. The coefficient estimates for IDAs within 15 kilometers and bordering IDAs are actually slightly smaller than the estimates for IDAs within 20 kilometers. This is somewhat surprising and perhaps the result of limited variation in the competition measures at these short distances, but nonetheless suggests that the effect of competition is not entirely driven by extremely close competitors.

In Appendix Table 4, I consider the effect of competition on exemptions for firms in different sectors and with different number of employees. I find little difference across sectors, but do find a smaller effect of competition for firms with fewer than 10 full-time-equivalent employees. Finally, in Appendix Table 5, I consider nonlinear effects of competition and find some weak evidence that the effect of additional competition fades as the number of nearby IDAs increases.

5 Model Specification, Estimation, and Identification

5.1 Specification

The previous section suggests that spatial competition increases tax breaks, consistent with the proposed model. In order to study further questions—such as how competition affects firm location, how those firm location changes affect allocative efficiency, and how proposed policy reforms reducing competition would affect the total amount of exemptions—I now parameterize and estimate the model presented in Section 3.

Firm model: Firms follow a two-step decision process, first drawing a town as a preferred location. Firm f in sector s that eventually located in town h in year t draws town j with probability:

$$P_{fj} = \frac{new\_unsubsidized\_firms_{jst}}{\sum_{d(i,h)<40} new\_unsubsidized\_firms_{ist}} \tag{4}$$

if the distance $d(j,h)$ between j and h is less than 40 kilometers and 0 otherwise. Here, $new\_unsubsidized\_firms_{jst}$ is the number of establishments in sector s observed to locate in town j in the years $t-1$ to $t+1$ in the ReferenceUSA data. In words, I assume that the preferred location was not too far from the final location and that towns that attracted more firms similar to f are more likely to have been f's preferred location. I choose 40 kilometers as the maximum distance because this is the radius at which the number of IDAs has no effect on exemptions.

After a firm draws a preferred location j, each town submits a tax exemption offer b. Given those exemption offers, firms choose their final location. Similar to a Hotelling model, firm profit from a given location depends on its distance from the firm's preferred location. Firm f's profit from location k is given by:

$$\pi_{fk} = \beta_{dist} * d(k, j) + \beta_{tax} * (\tau_k - b_{fk}) + \epsilon_{fk} \tag{5}$$

where $d(k, j)$ is the distance between k and preferred location j, τ_k is the base property tax rate in town k, b_{fk} is the average exemption over the next fifteen years, and ϵ_{fk} is a logit error term with variance σ^2. Returning to Figure 3, β_{dist} determines the relative height of the hollow and solid bars, and σ^2 determines the height of the hashed bars. Firm f chooses the location k^* that maximizes π_{fk}.

Town model: Towns act after firms have revealed their preferred location and before they choose their final location. While I allow valuations to vary across towns in an extension, in the baseline model each town receives a common value v_f for landing the firm:

$$v_f = \kappa_{prop} * property\_value_f + \kappa_{emp} * jobs_f \tag{6}$$

Towns know firm preferences up to the error term and choose b_{fj} to maximize their expected value in a Bayesian Nash Equilibrium. I do not explicitly model changes to equilibrium rents or wages that result from landing a firm, but I assume that they are accounted for in a town's valuation.

To maintain tractability, I restrict the set of exemption offers a town can make. Rather than allowing arbitrary multi-year agreements, I allow towns to choose from 10 separate 7-15 year agreements that span the agreements observed in the data. Because IDAs offer tax exemptions, not cash transfers, τ_j is the maximum value for b_{fj}. I model only property tax exemptions and assume that state sales tax exemptions or credits from other programs will be constant across locations.

For simplicity, I consider only towns and not county IDAs in the main text. I assume county IDAs maximize the average value over the towns within their borders that do not have their own IDA. I allow counties to offer a uniform tax break across all such towns, but not different tax breaks in different towns. I discuss this in full detail in Section 3 of the Appendix.

This parameterization implies that firms first zero in an area and then choose a particular town in that area. In other words, firms are no longer debating between locating in Buffalo and Albany when collecting tax break offers; they are only considering locations in one area or the other. Though this model is not well-suited for the large national site searches that tend to attract media attention, it may be a reasonable approximation for many businesses in my sample, which is largely composed of small firms. For example, it is consistent with a small business whose owner does not want to work too far from home, a new retail store that wants to be near a particular space where demand is concentrated, or a corporate office or manufacturing firm that is looking for a new location but does not want to move its existing employees. Moreover, the surveys described in Section 2 find that local governments most often compete against neighboring localities, suggesting that a large number of firms conduct local searches. Finally, the dummy for a nearby state border is not statistically significant in the regressions presented in Section 4, suggesting that even very close states may be outside the choice set for firms in my sample.

Turning to the firm profit function, it would perhaps be more intuitive to include town amenities or characteristics instead of only distance from a preferred location. However, most of the characteristics firms describe as important—labor force, transit connections, supply chain logistics—are characteristics of an area rather than a single town. Moreover, different firms may care about very different things, and it is not clear how to capture complex preferences that vary across firms using available data.

In order to concisely summarize differences across towns, I set distance from a preferred location as the key characteristic determining firm profit. Profits are highest in the preferred location and then decrease with distance as the area changes and becomes less appealing. While this is an approximation, recall from Section 4 that the effect of competition on exemptions fades rapidly as the radius on the competition measure increases. This suggests that nearby towns are closest substitutes for a firm, implying that distance may capture a large portion of the differences across towns. I use geographic distance between locations, rather than car commuting time, because it is highly correlated with transport time by car, rail, or waterways.

I first estimate the base model as presented above and then tweak that model in two ways. First, because distance and property taxes may be differently important for different types of firms, I estimate the model separately for manufacturing/finance and retail/services sectors. Second, I introduce systematic heterogeneity in town valuation of firms in order to both allow another source of changes in firm location and further explore allocative efficiency.

5.2 Estimation

I apply a number of restrictions to construct the sample of projects used in model estimation. First, in order to remain consistent with the model of profit-maximizing mobile firms, I continue to exclude civic projects, projects managed by nonprofits, agricultural/forestry/fishing projects, and transportation/communication/electric projects from the sample. Second, because the model predicts that IDAs will compete on local taxes and meet firm's requests on state taxes, I include only projects that receive exemptions on local taxes.[16] Lastly, in order to avoid reporting inaccuracies and legacy projects, I exclude the small number of active projects that began receiving exemptions before 1993. Because these restrictions shrink the size of the sample, I utilize the 2008 data in addition to the 2013 data. This enables me to include firms that received exemptions in 2008 but not in 2013, expanding my sample to 2,224 firm-specific agreements.

I estimate the model via indirect inference, using coefficients from the IV estimates of Equation 3 (with log total exemptions as the dependent variable) presented in Section 4 as the matched auxiliary model. In particular, I denote the coefficient on $\#(IDAs\ in\ x\ km)$ as γ_x and match $\bar{\gamma} = \{\gamma_{25}, \gamma_{30}, \gamma_{35}, \gamma_{40}\}$, estimating a separate regression for each radius x. I also match the sum of all exemptions, the percent of towns with at least one exemption, the amount of the 25th percentile exemption, and the correlation between the number of

[16]Some firms receive only tax-exempt bonds or sales tax exemptions on purchases.

jobs in a project and that project's received exemption. I compute this vector of moments and regression coefficients using both the 2008 and 2013 data and call it ϕ. The parameters to be estimated are the disutility of distance β_{dist} in Equation 5, as well as κ_{prop} and κ_{emp}, which govern the relationship between firm characteristics and town valuation in Equation 6. As explained in the upcoming identification section, I calibrate the error σ^2 in firm profit.

The simulation process used to estimate the fit of a vector of parameters $\tilde{\theta_d} = \{\beta_{dist}, \kappa_{prop}, \kappa_{emp}\}$ in draw d proceeds as follows:

1. I simulate N sets of exemptions and firm locations given $\tilde{\theta_d}$. To generate each simulated data set, I follow the below steps for each firm observed to receive an exemption in the data:
   - Simulate a preferred location draw using calibrated probabilities.
   - Compute an equilibrium in exemption offers from IDAs.
   - Simulate the firm's final location given its preferred location and the exemption offers.
2. I then compute the auxiliary moments $\hat{\phi}_{di}$ for each of the N simulated data sets.
3. I take the mean of $\hat{\phi}_{di}$ to arrive at the average moments $\hat{\phi}_d$ for the parameter draw d.
4. I compute a distance metric $D_d = (\hat{\phi}_d - \phi)W(\hat{\phi}_d - \phi)$, where ϕ is the true moments in the data and W is a weighting matrix.[17] This is the measure of fit for the parameter vector $\tilde{\theta_d}$.

I take the vector θ^* that minimizes the distance metric D as my parameter estimates. Though the optimization problem is nonlinear, it is well-behaved and converges to the same estimates from diverse starting points. For more detail on estimation, see Section 3 of the Appendix.

[17] I use a two-step procedure to compute W. I first estimate the parameters using the covariance of the data moments as a weighting matrix. I then simulate the moments under those parameter estimates and compute their covariance matrix. Finally, I take W as the diagonal of that covariance matrix. I use only the diagonal because the full matrix is nearly singular and creates computational difficulties.

5.3 Identification of Structural Parameters

The same exogenous variation in competition that drives my reduced form estimates identifies the structural model parameters, as differences in IDA behavior across different competitive environments can be mapped to parameter estimates. For this approach to yield meaningful estimates, IDAs must behave optimally and have knowledge of firm preferences. While it is not immediately obvious that this is the case, there is evidence suggesting that economic development agencies are sophisticated. Shoag and Veuger (2015) show that the tax breaks offered by towns are larger when the town will capture more of the spillovers of the subsidized business, and this paper shows a positive relationship between competition and tax breaks. Anecdotally, local governments put a striking amount of effort into economic development. For example, Central New York's Madison County, which has a population of 70,000, has a professionally produced 24-page economic plan.

In lieu of a formal identification proof, I describe the heuristic features of the data that serve as the primary identification for each parameter. While all the parameters of the model could in principle be identified from the observed moments, in practice, the data is too noisy to confidently identify all of the firm profit parameters (β_{tax}, β_{dist}, and the variance σ^2 of the error term). In particular, when σ is between 1.33 and 2.5 and β_{tax} is normalized to 1, there is a set of local minima which are too similar to confidently distinguish between.[18] However, fixing a σ within this range, the distance function is well-behaved and has a unique minimum. I thus calibrate σ within this acceptable range and discuss identification holding this parameter fixed. The model produces very similar counterfactual estimates for the different calibrations of σ.

First, consider the firm profit function. With β_{tax} normalized to -1, β_{dist} can informally be interpreted as the size of tax break needed to 'move' one kilometer closer to the preferred location. For example, if β_{dist}=-2, a two mil (.2%) decrease in the tax rate is equivalent to being one kilometer closer to the preferred location. This parameter will be primarily identified by the set of regression coefficients $\bar{\gamma} = \{\gamma_{25}, \gamma_{30}, \gamma_{35}, \gamma_{40}\}$. Figure 5 shows simulations of $\bar{\gamma}$ under three values of β_{dist}.

When β_{dist} = -2.5, as shown in the dashed line, competition is generally low and fades out

[18] Outside of this range, the simulations do not match the actual dispersion of firms in the data.

quickly. When β_{dist}= -1.66, in contrast, competition has a much larger effect on exemptions, because IDAs gain more from offering the marginal exemption. When β_{dist} moves to -1.33, two changes occur. First, competition fades out more slowly with distance, as γ_{35} and γ_{40} increase. This occurs because when β_{dist} is smaller, IDAs from a greater distance can 'make up' for their poor location with tax breaks and influence the bids in an auction. Additionally, γ_{25} decreases slightly, because it takes less competition to induce towns to make the maximum bid and additional IDAs beyond that point generate no further changes. This flattens the relationship between IDAs and exemptions and shrinks the regression coefficient. These distinct shapes of $\bar{\gamma}$ identify β_{dist}.

Turning to town's valuation of firms, κ_{prop} and κ_{emp} are primarily identified by the sum and 25th percentile of exemptions. Figure 6 shows how the sum monotonically increases with increases in κ_{prop},[19] as towns are willing to offer a larger tax break when they value a firm more. Of course, a given sum and 25th percentile could be produced by a large κ_{emp} and small κ_{prop} or vice versa. The correlation between a project's number of jobs and received exemption identifies the relative importance of jobs and property value.

In addition to the relationships shown in Figures 5 and 6, increases in the town valuation parameters generally shift $\bar{\gamma}$ up and increases in β_{dist} decrease the sum of tax exemptions. However, crucially for unique identification of the structural parameters, one cannot simply increase both of these parameters and have no effect on the simulated moments.

For example, suppose that, starting from a locally optimal set of parameters, one increases κ_{prop} and increases β_{dist}. This may replicate the sum and 25th percentile of subsidies if the changes are made so that the change in κ_{prop} exactly offsets the change in β_{dist}, but it will change $\bar{\gamma}$. Increasing β_{dist} steepens the gradient of $\bar{\gamma}$, making competition fade out more quickly with distance, while increasing the town valuation parameters only shifts $\bar{\gamma}$ down without affecting the gradient. Thus, this change will have a negative effect on this dimension of model fit.

[19]The pattern is very similar for κ_{emp}.

6 Model Results and Counterfactual Simulations

6.1 Parameter Estimates and Fit

Table 7 contains estimates of the model parameters. Panel A shows $\{\beta_{dist}, \kappa_{prop}, \kappa_{emp}\}$ for the full sample, while Panels B and C show estimates within the manufacturing/finance and retail/services sectors, respectively. Each row represents a different calibrated value of σ. Although all calibrations of σ result in very similar counterfactual simulations, there are differences in the estimates of the other parameters. For this section, I focus only on the middle row, where $\sigma = 1.67$. In the firm profit function for the full sample, β_{dist} is equal to -1.637. This implies that a 1.637 mil (.1637%) reduction in the average tax rate over the next 15 years is equivalent to being one kilometer closer to a firm's preferred location. Since the average property tax rate in New York is 29 mils, this in turn implies that if a town exempted all of its property taxes, it would be as attractive as a town that is 18 kilometers closer to a firm's preferred location. Firms must be elastic over only this small geographic area in order to rationalize the data, in particular the observed rapid fade with distance of the $\bar{\gamma}$ regression coefficients.

Though 18 kilometers seems like a short distance, the model parameters actually translate to a relatively high elasticity of new business establishments to town tax rates—approximately -3.[20] That is, if a town lowers its tax rate by 1%, the number of establishments it attracts will increase by 3% on average. This elasticity is slightly larger than the -2 average reported in the Bartik (1991) and Wasylenko (1999) literature reviews. This may be explained by the set of firms which receive IDA tax breaks, which are likely selected on high mobility.

On the agency side of the model, I find κ_{prop} to be equal to .292 in the full sample, while the estimate of κ_{emp} implies that towns value each job at $43,500. The estimate of κ_{prop} implies that the average IDA values property at about two-thirds of the tax revenue that would be collected over 15 years with a tax rate near the state average of 29 mils. While the job valuation may appear somewhat high, it's common for state and local governments

[20] To compute a simple elasticity, I simulate the number of firms that a town would attract with its actual base tax rate and if it were to lower its base tax rate by 10%, in both cases allowing no tax breaks from any town. On average, the number of firms attracted to the town increases by 31%. This number is skewed by a few towns with very large gains, as the median town experiences a gain of only 9%.

to make agreements in which the exemption dollars per job far exceed \$45,000. Intuitively, towns seem to value manufacturing and finance firms ($\kappa_{prop} = .31, \kappa_{emp} = 63,800$) more than retail/services firms ($\kappa_{prop} = .21, \kappa_{emp} = 38,400$). This likely occurs because manufacturing and finance jobs are generally higher paying and may have larger spillover effects than jobs in retail or services.

To assess the model fit, I compare simulated moments under the estimated parameters to actual moments in Figure 7. The figure shows simulations under the full sample estimates from Table 7 with $\sigma = 1.67$; the other calibrations and subsamples are similar. The top panel shows the moments used in estimation, while the bottom panel shows the distribution of total town exemptions among towns with some exemptions, which was not matched in estimation. In both graphs, the model largely fits the data.

6.2 Counterfactual simulations

Using those parameter estimates, I run simulations for three policies. First, I simulate exemptions and firm locations under the status quo regulations. I then simulate the dissolution of all town IDAs, leaving county IDAs to represent every town in their jurisdictions. Lastly, I simulate a tax break ban, in which IDAs are not allowed to offer any exemptions.

Figure 8 shows the simulated tax exemption total for each policy regime, using the baseline parameter estimates with the full sample of firms and $\sigma = 1.67$. Removing town IDAs reduces the number of competitors in each auction and decreases total tax breaks by roughly 30%, while the exemption ban obviously lowers tax breaks to 0. Like the descriptive portion of the paper, the simulations suggest that policies that reduce competition could decrease the total transfer to the private sector. I present results separately for retail and services firms, which are more likely to conduct the local searches best represented by the model, in Appendix Figure 2. The results are quite similar to the full sample.

I next examine how often firm location changes across the counterfactual policies in Table 8. Focusing on the first column, which shows results in the full sample with base parameter estimates, the town with the highest probability of landing a given firm is the same across all three counterfactuals in 82-88% of the firm auctions, depending on the value of σ.[21] These results are very similar under the sector-specific parameter estimates and for the retail/services subsample. Additionally, Appendix Table 6 shows that the set of towns with a probability higher than 25% of landing a particular firm changes minimally across counterfactuals. The establishments in the estimation sample accounted for about 300,000 jobs in total, of which approximately 15% change location between the exemption ban and the status quo. The total, undiscounted amount of tax breaks (summed over the duration of multi-year agreements) increases from \$0 to \$1.8 billion across these two simulations, implying a cost of about \$50,000 in tax breaks for each job moved.

While increasing competition increases bids, it does not seem to have a large effect on where firms choose to locate.[22] Since firm locations do not change very much, there is limited scope for changes in allocative efficiency. However, it is still possible that the small proportion of firms that do move across simulations have an effect on efficiency, and it is also possible that adding heterogeneity to the town valuation of firms would lead to more moves. I study these questions by introducing heterogeneity in valuations in Section 6.4.

There are a number of caveats to these simulations. First, I assume that firms do not consider locations in other states or distant regions of New York State. If many firms conduct such searches, I would overestimate the effect that reducing local competition has on exemptions. It may be that competition from South Carolina is actually driving tax break offers, so removing an IDA one town over is unimportant. However, given that local competition has a large effect on exemptions in Section 4, it seems likely that removing IDAs would indeed lower tax breaks.

Competition from other states would also affect my results on firm location, particularly when simulating the dissolution of all IDAs. Firms may locate outside the state without tax breaks, which the model does not allow. While an alternative model that includes other states would be different in many ways, firms would still have to be relatively inelastic over locations within a metropolitan area in order to match the observed $\bar{\gamma}$ coefficients. This would likely lead to IDAs having little effect on firm locations within the state, though it is harder to extrapolate further to firm movement across states.

[21] On average, the most attractive town in an auction has a win probability over 90%.

[22] This result holds given the types of tax exemptions IDAs can currently offer. If they could offer exemptions on additional types of taxes or make cash transfers, firm locations may change more frequently.

Second, the firm profit function depends only on distance from a preferred location. This rules out potentially important heterogeneity across locations at similar distances from the preferred location. For example, firms could actually be extremely elastic across the preferred location and one neighbor, and the model structure would compute an average elasticity over all the towns at a similar distance from the preferred location. This assumption could decrease firm mobility in simulations.

Finally, some projects may not occur in the absence of tax exemptions, though the IDA officials interviewed for this paper thought this was uncommon.

6.3 Mechanism

Locations stay relatively constant not only because firms are somewhat inelastic to tax rates, but also because of equilibrium IDA behavior. As illustrated in Figure 3, towns that are attractive in the regime with no tax exemptions respond to policy changes that introduce competition by offering exemptions and thus maintaining a high probability of landing the firm. These towns have an advantage due to their location, and while they do have to offer exemptions to compete with other towns once tax breaks are introduced, they are generally able to maintain their initial 'lead' and land the firm.

I illustrate this mechanism using model estimates in Figure 9, in which I simulate a single firm arriving with the town of Amherst as its preferred location with different numbers of nearby IDAs. I first simulate the firm's arrival with all five of the IDAs within 40 kilometers of Amherst turned off, and then turn them back on one by one, repeating the simulation each time. The solid line plots the Amherst IDA's equilibrium bid across these different levels of competition, and the blue line plots Amherst's probability of landing the firm. In Panel A, which uses the estimated parameters with $\sigma = 1.66$, Amherst gradually increases its bid as more IDAs are turned on and maintains a very high (over 95%) probability of winning the firm. This example maps directly onto the result that increased competition increases total tax breaks but does not affect equilibrium firm location.

In order to illustrate the patterns in the data that drive the result on changes in firm location, Panel B repeats the above exercise with altered firm profit parameters. I increase the noise σ from 1.66 to 6.66 and decrease the disutility of distance β_{dist} from 1.63 to 1.

Now, Amherst makes the maximum bid immediately when competition is introduced, and its probability of landing the firm decreases to below 70% when all five IDAs are active. This largely occurs because other IDAs are a bigger threat under this set of parameters. Distance is less important, so Amherst's initial lead is smaller, and the IDAs introduced under different policy regimes have enough power to change the firm's location. This intuition carries through to the counterfactual simulations, which show much more firm movement under these alternate parameters.

However, these parameters do not match three key moments in the data: γ_{35}, γ_{40}, and the percent of towns with at least one firm receiving exemption. Tax exemptions are very powerful under the alternative parameters, leading to simulated values of the γ_{35} and γ_{40} regression coefficients that are much larger than the zeros observed in the data. IDAs from further away would influence bids if exemptions were so important. The high level of noise in firm profit also leads to too much dispersion of firms across towns. The simulated moments obtained under these alternative parameters are closer to what might occur in a specific sector in which firms are very elastic across locations—such as the growing data center industry or certain segments of the film industry—but do not match the patterns observed in the IDA data.

6.4 Heterogeneity in Town Valuation of Firms

Though firms rarely change location across policy regimes in the base estimation, the firms that do move may land in locations where they generate a larger social surplus. In order to directly compare town surplus across counterfactuals, as well as to potentially increase the number of firms that change location, I extend the model to allow the valuation of firms to vary systematically across towns. I use total town surplus as the measure of efficiency in this section, assuming that differences in firm profits across towns do not enter the welfare function.[23]

[23] After running simulations, I also check firms' average distance from their preferred location, a measure of the distortion of their location choice, and find minimal changes across counterfactuals. This occurs both because few firms move and because the firms that do move when IDAs are introduced sometimes actually move closer to their preferred locations, as differences in base tax rates distorted their choices in the regime with no IDAs.

A major challenge of this exercise is choosing which town characteristics predict social surplus. While there seems to be an informal perception in the media that the spillovers from economic development are larger in poor, blighted, or declining areas, there is little empirical evidence on heterogeneity in spillovers.[24] I parameterize town valuation to depend on the percent of the population in the town that is below the poverty line, which is correlated with many characteristics informally thought to be associated with high spillovers. This exercise is not a conclusive test for the existence of allocative efficiency gains, but rather examines one possible channel. In the future, I plan to investigate other characteristics that could predict heterogeneity of town valuations.

Formally, I change town valuation of a firm in Equation 6 to

$$v_{fj} = (1 + \beta_{pov} * percent\_pov_j)(\kappa_{prop} * property\_value_f + \kappa_{emp} * jobs_f) \tag{7}$$

where β_{pov} is a new parameter to be estimated. I leave the remainder of the model unchanged. In order to identify β_{pov}, I include in the set of matched moments the percent of firms that locate in towns in each decile of poverty. The more firms locate in towns in the higher deciles of the poverty distribution, the larger the estimate of β_{pov}. However, note that because there is a maximum tax break bid, it may be difficult to distinguish between high levels of heterogeneity that produce the maximum bid for similar sets of towns. I discuss later how higher levels of heterogeneity would affect my results.

Parameter estimates and simulation results are shown in Table 9. Panel A compares the base model and the model with heterogeneity. I estimate β_{pov} to be 1.11, implying that a town with 14% poverty (the 90th percentile) would value a firm 11% more than a town with 4% poverty (the 30th percentile). This leads to an average range in town valuations within a firm's choice set of 25%. However, this substantial heterogeneity does not increase firm movement across counterfactuals, as the percent of firms with the same most probable location remains at 85%. One reason why firm movement does not increase by more is that there is a maximum tax break bid, which limits the ability of high-valuation towns to differentiate themselves.

[24]Suárez Serrato and Wingender (2016) show some evidence that employment multipliers from fiscal spending are larger in areas with previously low economic growth.

Panel B shows allocative efficiency results from the model with heterogeneity. Total town surplus increases by a very small amount as tax break administration becomes more decentralized. The average valuation for a firm in the town in which it locates is approximately \$5,914,000 under the status quo, \$5,908, 000 with only county IDAs, and \$5,864,000 with no IDAs. The efficiency gains in the status quo relative to the scenario with no IDAs or only county IDAs occur because town IDAs bid higher when they have a higher valuation for a firm, which nudges firms towards those high valuation towns. However, this force appears to be quantitatively small in this setting, largely because few firms change location. In contrast, differences across counterfactuals in tax breaks are large. The average exemption received by a firm, summed over the entire multi-year agreement, is \$1,033,000 in the status quo, \$703,020 with only county IDAs, and zero with no IDAs. For this particular implementation of heterogeneity, the small allocative efficiency gains from IDAs are overwhelmed by the large increase in total tax breaks.

Because the data may not be able to distinguish between very high levels of heterogeneity, it is useful to consider how larger heterogeneity would affect results. Note that increased heterogeneity would be unlikely to substantially increase the number of location changes, as most losing IDAs already offer the maximum tax break with the estimated heterogeneity. They would not be able to make larger bids even if they had higher valuations. This allows a back-of-the-envelope calculation of the heterogeneity required for efficiency gains from IDAs to outweigh the increase in tax breaks. Assume (conservatively) that for higher levels of heterogeneity, the proportion of firms that change location between the exemption ban and the status quo regime remains below 20% and the difference in tax breaks between the regimes remains constant. Then the firms that move when IDAs are introduced must, in order to yield efficiency gains equal to the increase in tax breaks, relocate to towns that value them approximately twice as much as the town they chose under the exemption ban. Of course, even larger heterogeneity could yield greater gains. This is substantially larger heterogeneity than my estimate, in which the poorest town has a valuation approximately 60% larger than the least poor town.

7 Conclusion

This paper examines how competition between local governments affects firm-specific tax break agreements and business locations. I first present a conceptual framework of towns competing to attract mobile firms with tax breaks. The model suggests both that competition increases total tax breaks and that tax breaks can help push firms towards efficient locations. I then examine an implication of this model—that towns near more IDAs should have more tax break activity—using agreement-level data on the universe of firm-specific tax breaks given by local economic development agencies in New York State. I use the number of counties near a town, which is uncorrelated with observable town characteristics, to instrument for the number of agencies near a town and find a substantial effect of competition on tax breaks. An additional agency within 25 kilometers of a town increases the probability that at least one business in the town receives exemptions from 25% to 30% and substantially increases the total annual flow of tax breaks to businesses in that town. This is consistent with the model prediction and suggests that local competition is an important force in tax break activity.

I then estimate the model in order to study the effect of tax breaks on firm location and allocative efficiency. I use the estimated model to simulate firm locations and tax breaks under two counterfactual policies that reduce competition—banning both town and county tax exemptions and banning only town exemptions. I find that while both policies decrease total tax breaks, neither would substantially affect firm location, suggesting that there would be no major changes to allocative efficiency. A firm will usually choose the same town across the different counterfactuals—what changes is the exemption that the winning town offers. In an extension, I parameterize town valuations to depend on the poverty rate and find trivial gains in allocative efficiency from decentralization. Together, these findings suggest that tax break competition primarily serves to lower the tax rate on mobile firms.

Understanding how competition affects tax breaks and how tax breaks affect allocative efficiency is important for evaluating proposals to change which governments have the authority to offer tax breaks. For example, Rolnick and Burstein (1995) advocate that Congress use the commerce clause to intervene in tax break bidding wars between states. Funkhouser

(2013) and Badger (2014) make similar proposals, and the Arizona legislature recently enacted a moratorium on local tax exemptions for retail establishments in the greater Phoenix area. The Missouri and Kansas legislatures are currently debating legislation that would attempt to end the "border war" for businesses in the Kansas City area.

In addition, whether governments have the ability to compete could affect the outcomes of a variety of economic development programs. For example, prior literature has typically found much larger positive effects for federal Enterprise Zones than similar state programs. While there are several differences between state and federal programs, one notable difference is that state zone designation is typically easier to attain than federal. This could mean that competition is more of a force in state programs, perhaps explaining some of the difference in effect size.

There are several important caveats to my findings. First, the model is best suited to firms that are not conducting national searches. It may understate the true competition in national searches by considering only local options, and counterfactual simulations do not account for firms fleeing the state as a result of policy reform. My results lean heavily on the assumption that firms in my sample conduct local searches. Secondly, my results are specific to not only local tax breaks, but also to New York State. Further research should both examine local competition in other contexts and investigate the interactions between states trying to attract firms conducting national searches.

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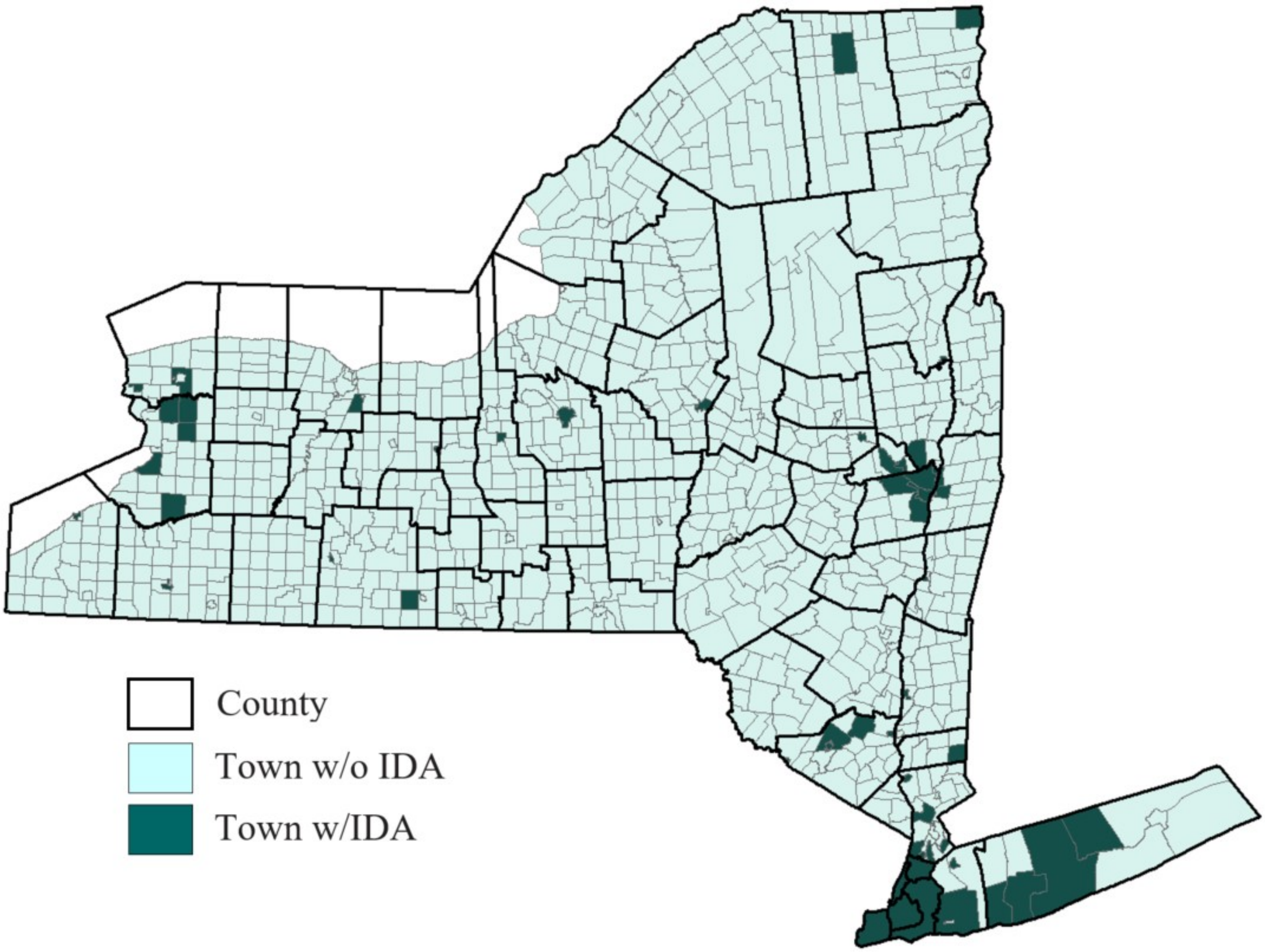
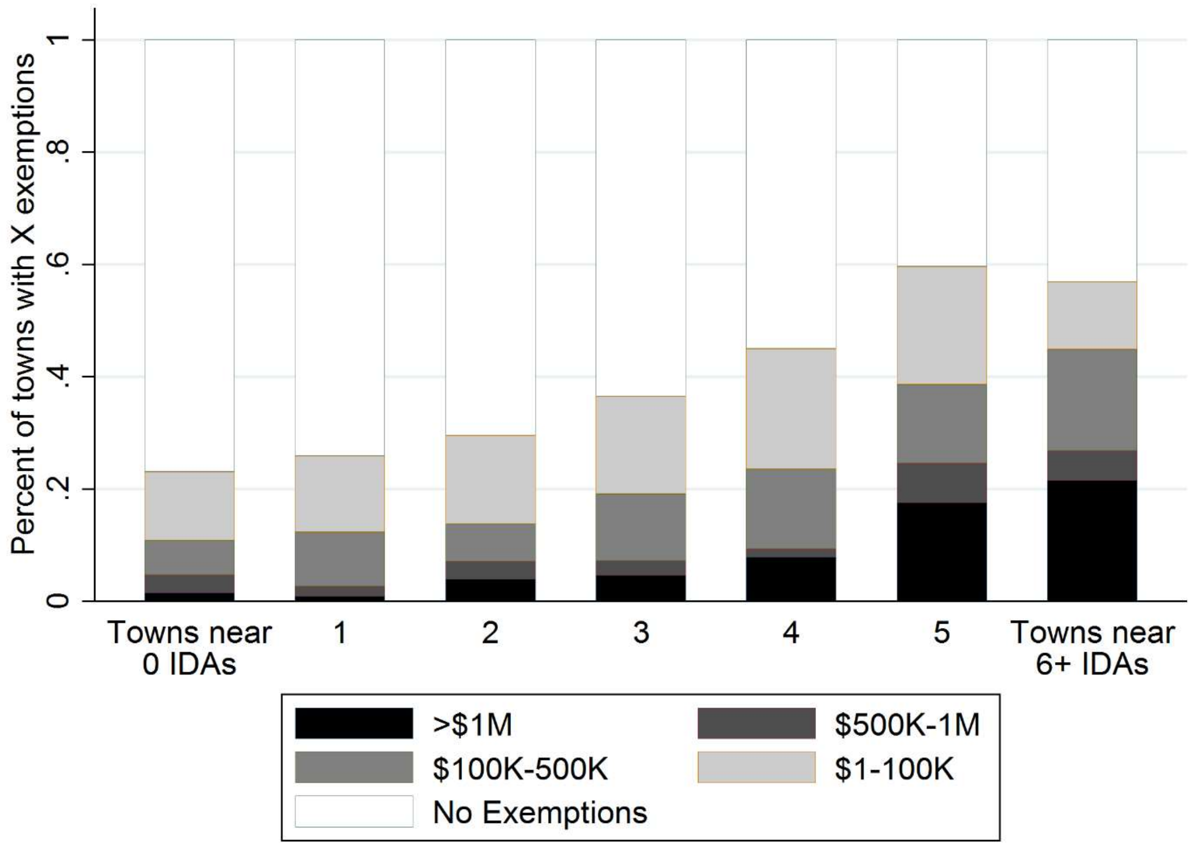
Figure 1: IDA locations in 2013



Note: The location of Industrial Development Agencies in New York State. The bold black boxes represent counties, each of which has an IDA which may offer tax breaks to firms located in any town in the county. The smaller boxes represent municipalities, and the darker colored boxes represent municipalities with their own IDA. Municipal IDAs offer tax breaks to firms within their jurisdiction.

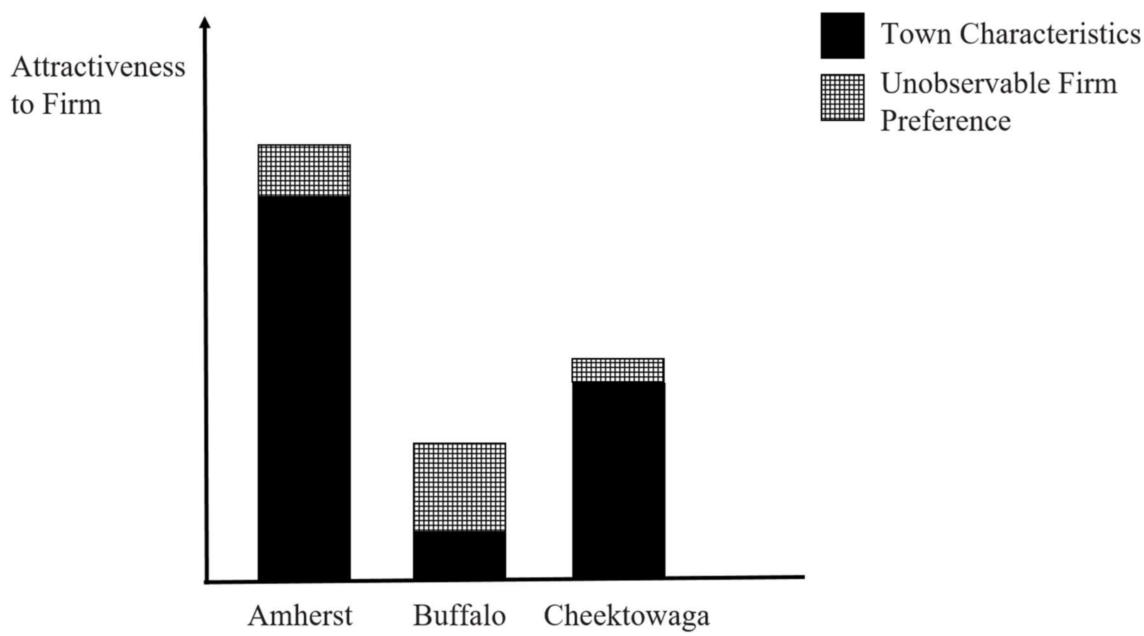
Figure 2: Exemptions versus number of IDAs within 25 kilometers



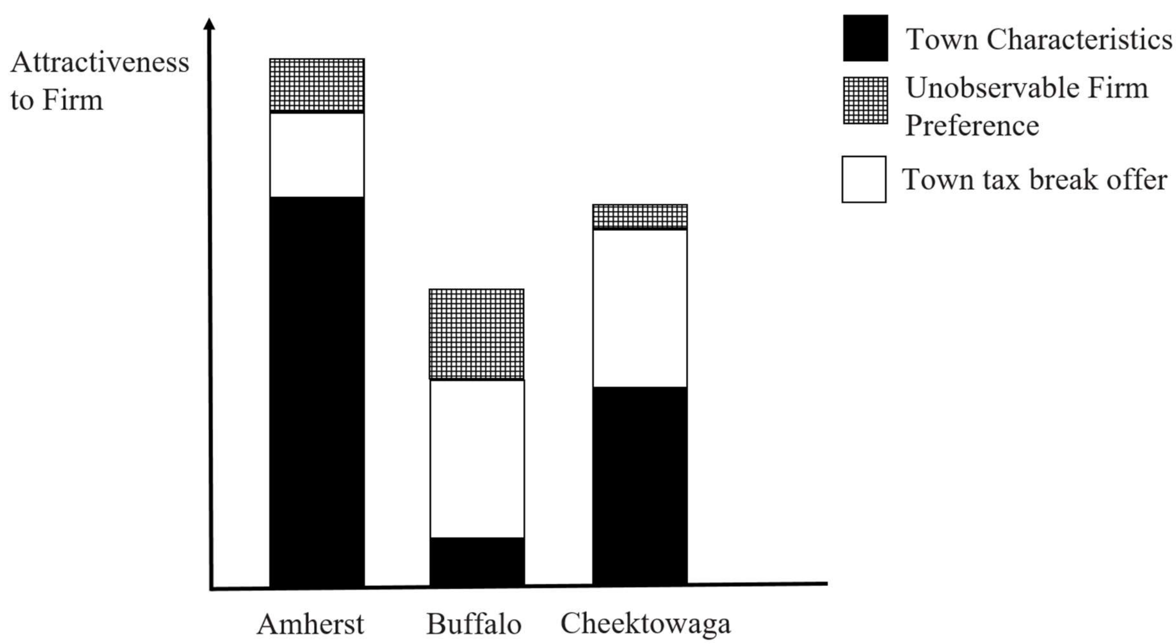
Note: This figure shows how tax break activity varies with the number of IDAs within 25 kilometers of a town. Each stacked bar represents the set of towns with a given number of nearby IDAs, and each bar is colored according to the percent of towns in that set with a given dollar amount of tax breaks in 2013.

Figure 3: Example of firm preferences with and without tax breaks

Panel A: Town tax breaks not allowed

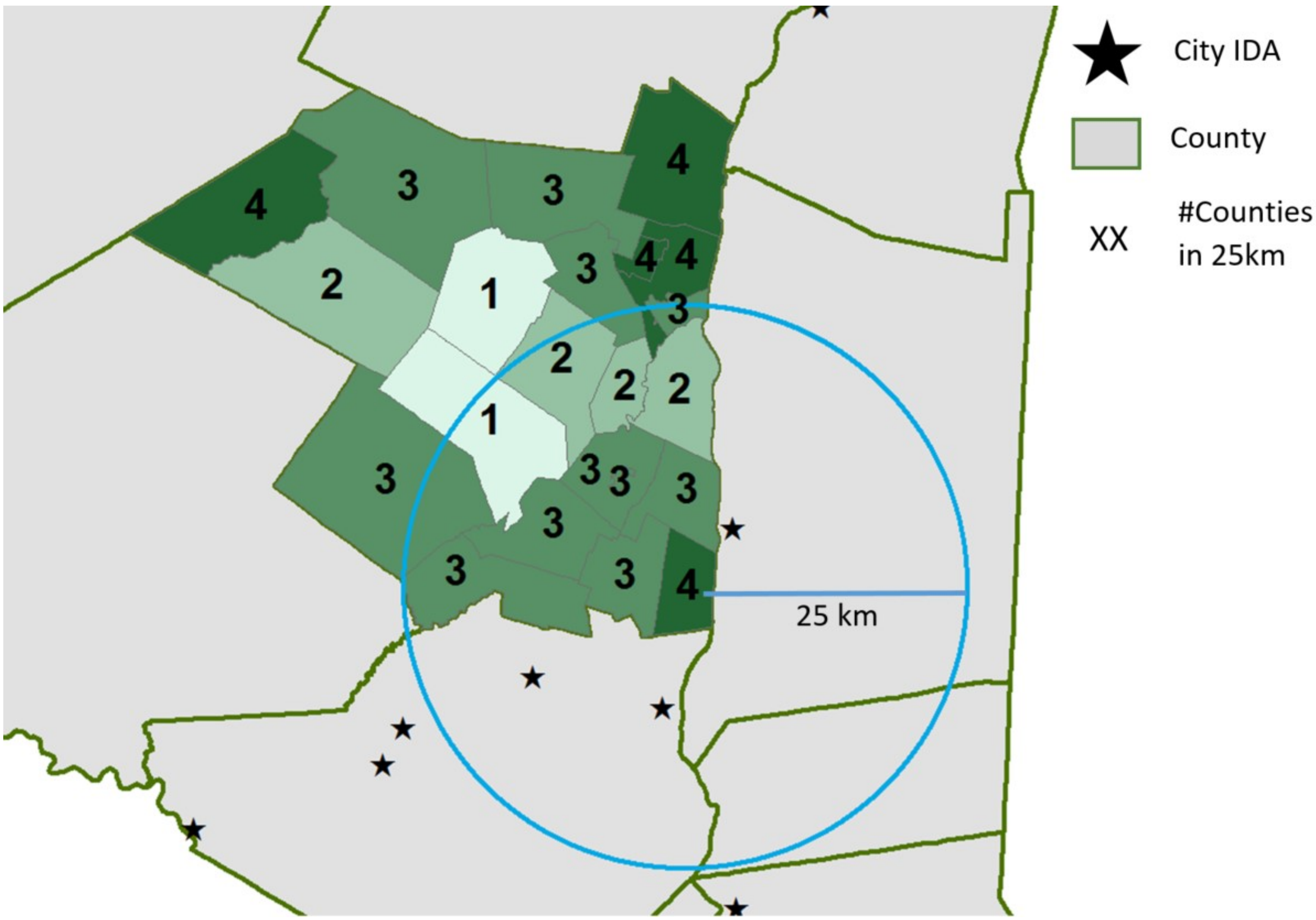


Panel B: Town tax breaks allowed



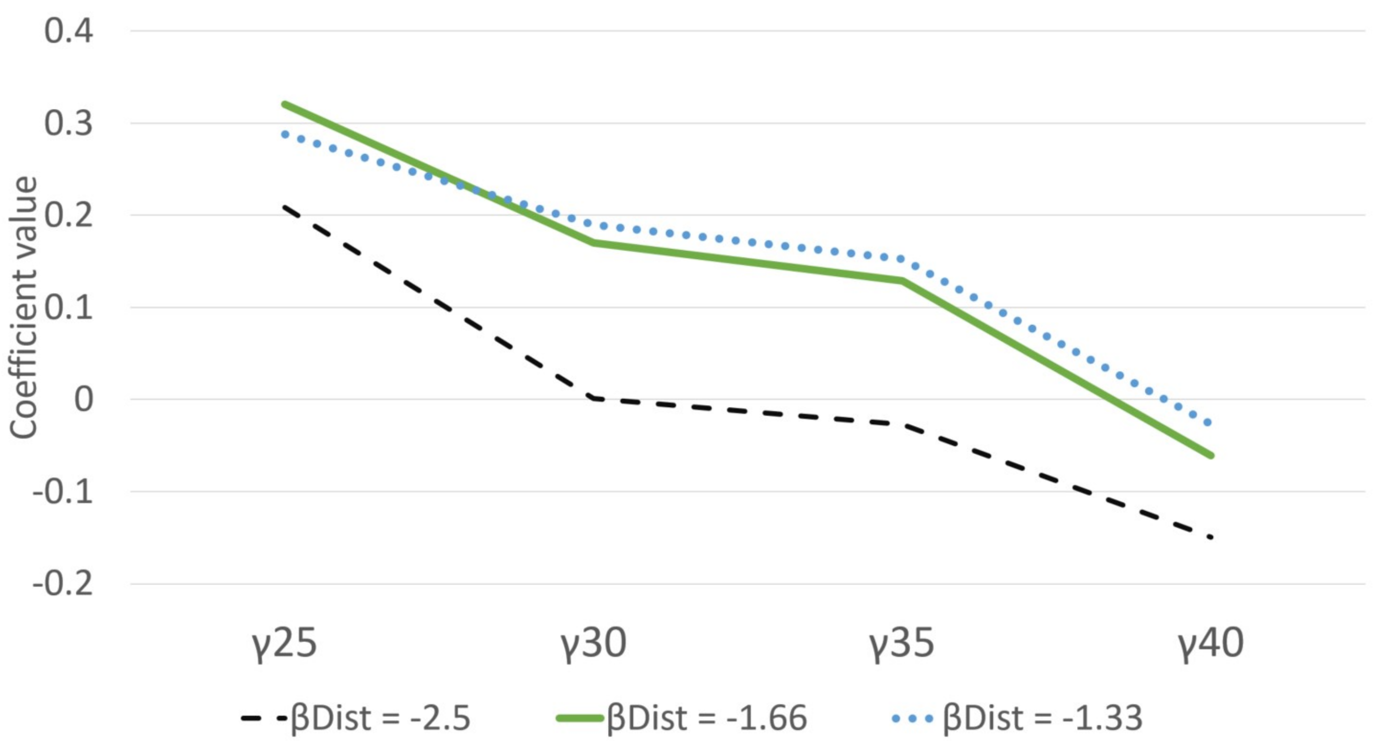
Note: This figure shows an example of how firm location preferences could differ across regimes in which town tax breaks are/are not allowed. The black bar represents town characteristics including the base tax rate (α from Equation 1), the hollow bar, equilibrium tax break offers (*b*), and the hashed bar, the error term in firm profit (ε). The stacked bar represents total town attractiveness.

Figure 4: Example within-county variation in counties within 25 kilometers of a town



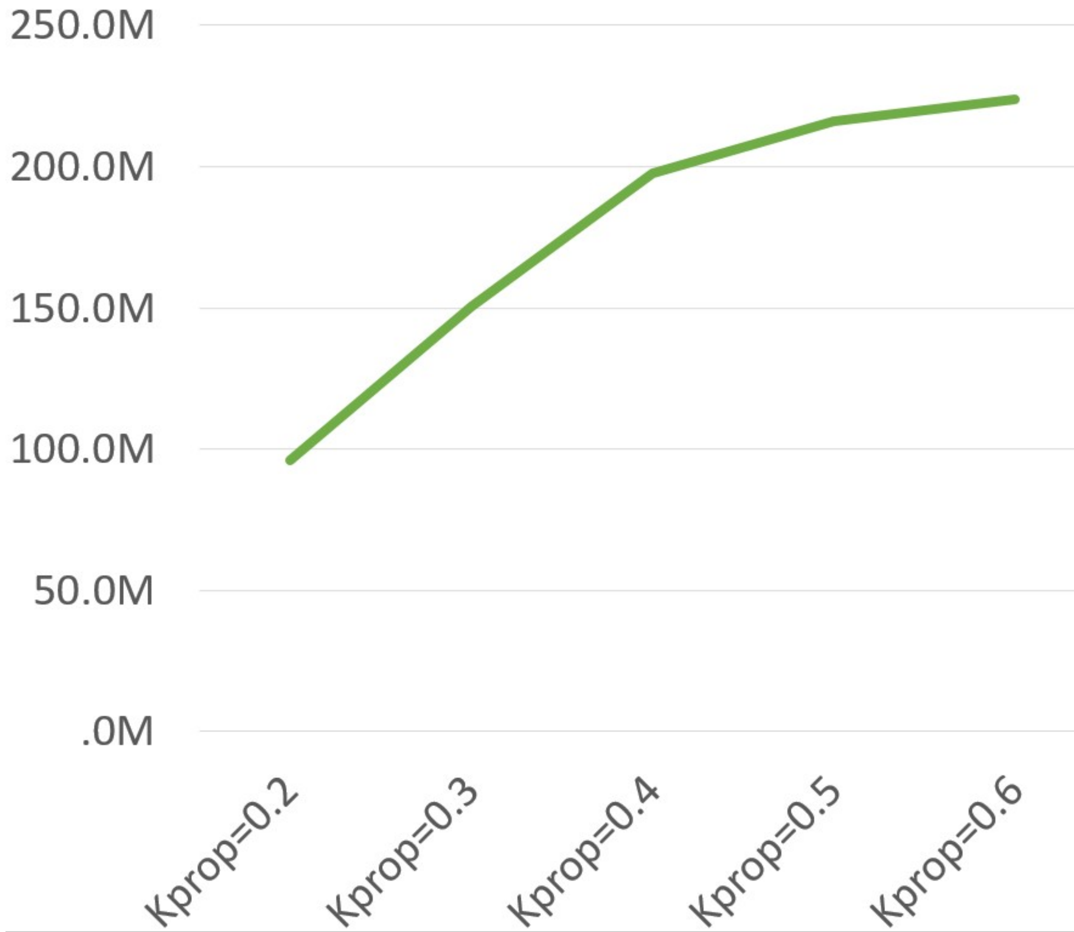
Note: The variation in counties within 25 kilometers across towns in Ulster County. This is the variation in the instrument used to estimate the relationship between IDAs within 25 kilometers and tax break activity. The numbers represent the number of counties within 25 kilometers. The large boxes are neighboring counties, while the stars represent nearby municipal IDAs. The circle represents an example 25-kilometer radius. Distance between a town and a county is defined as the distance between the centroid of the town and the nearest centroid of a town in the county.

Figure 5: Identification of β_{dist}



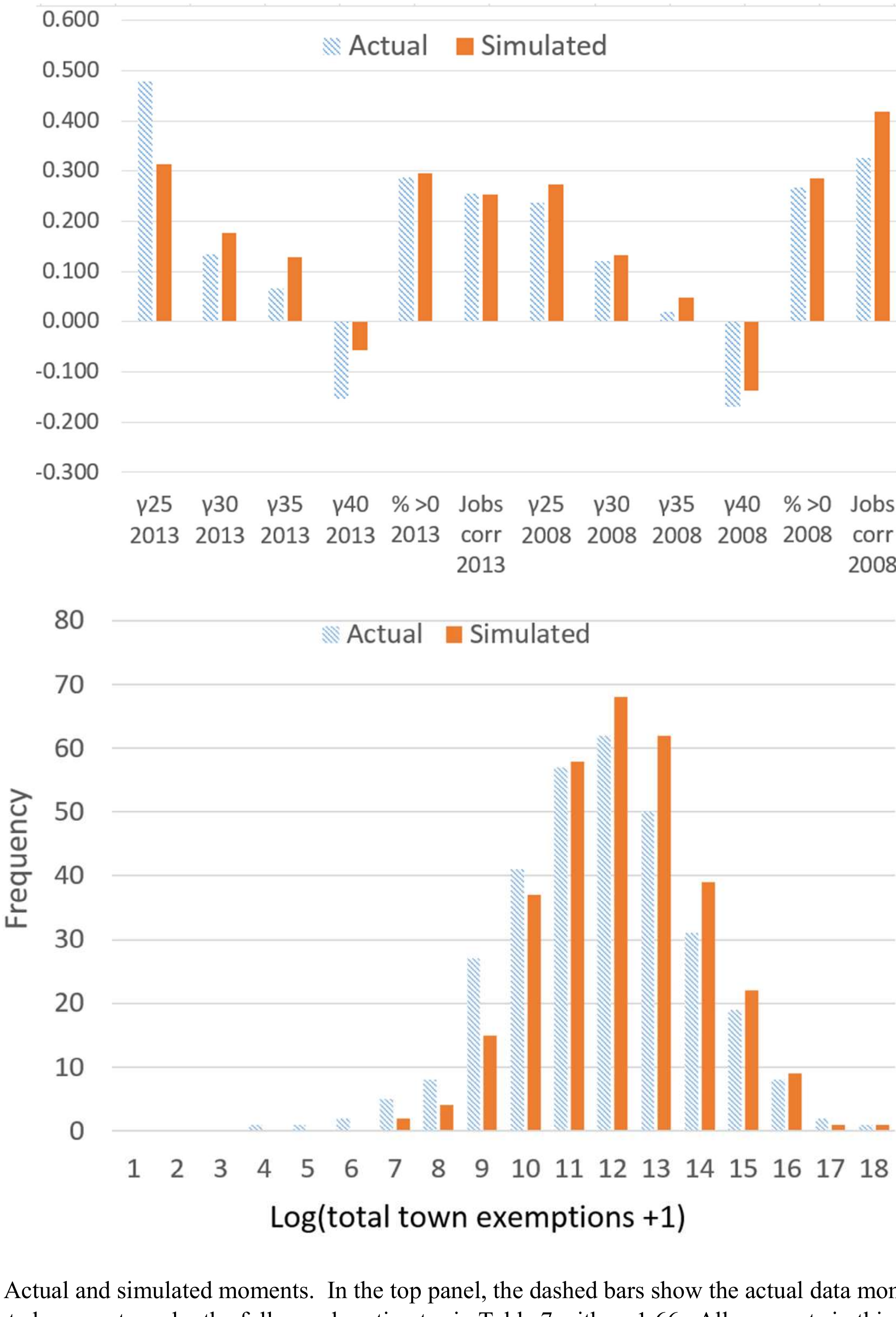
Note: Each line in the graph represents the simulated values of $\{\gamma 25, \gamma 30, \gamma 35, \gamma 40\}$ under a given value of β_{dist}, holding the other structural parameters constant at the estimated values. β_{dist} is the disutility of distance in the firm decision, with larger values implying that tax breaks are less important in firm decisions. γx is the coefficient on IDAs within x kilometers from an estimate of the IV specification in Column 4 of Panel B of Table 4 with a radius of x km (rather than 25) on the nearby IDAs measure. Larger observed $\{\gamma 25, \gamma 30, \gamma 35, \gamma 40\}$ that fade out more slowly with distance imply that tax breaks are more important relative to distance, leading to smaller estimates of β_{dist}. See Section 5.3 for more detail on identification.

Figure 6: Identification of κ_{prop}



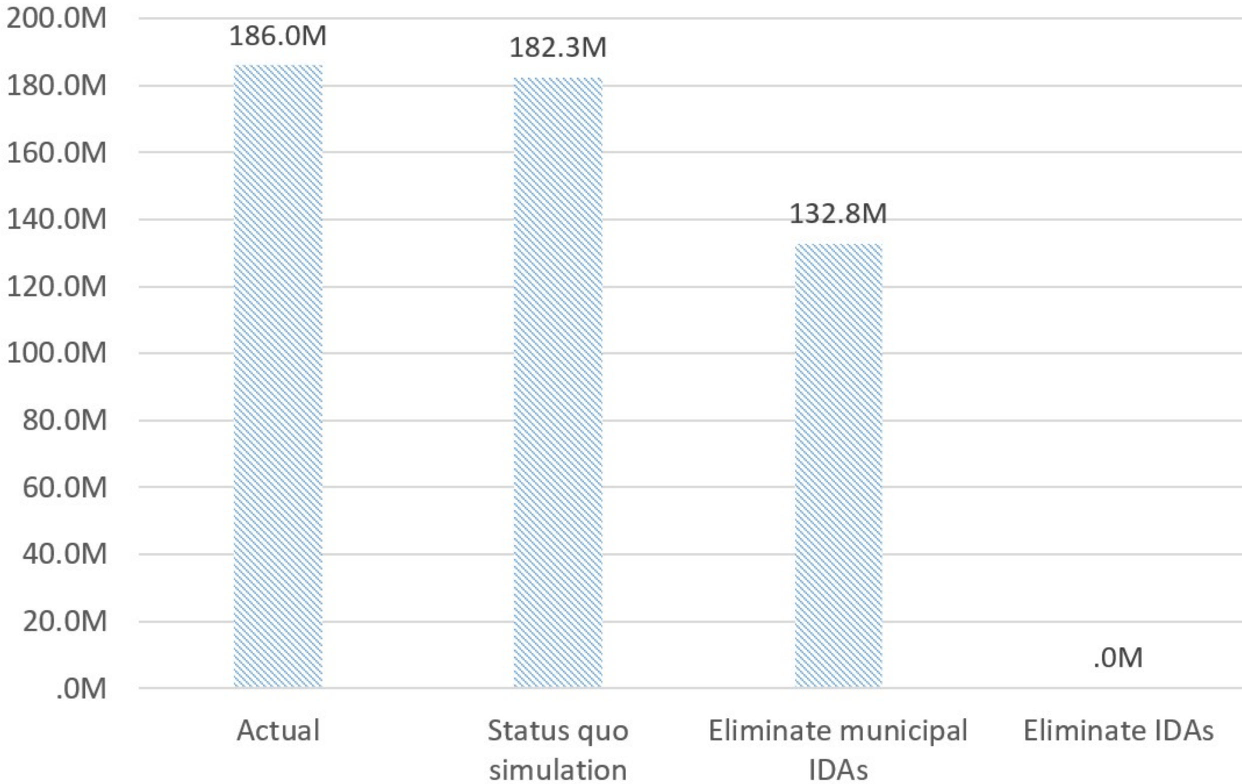
Note: The line represents the simulated values of the sum of IDA exemptions for a given value of κ_{prop} (town's valuation of a business's property value), holding the other structural parameters constant at the estimated values. The higher the sum of exemptions, the larger the estimated κ_{prop}. A similar graph can be generated for κ_{emp}, which is town's valuation of a business's jobs. The two parameters are separately identified by matching the correlation between a project's exemptions and its number of full-time equivalent employees.

Figure 7: Model fit of in sample and out of sample moments



Note: Actual and simulated moments. In the top panel, the dashed bars show the actual data moments, and the solid bars, the simulated moments under the full sample estimates in Table 7 with σ=1.66. All moments in this panel were used in the estimation. The bottom panel shows the simulated and actual distribution of total town exemptions, which was not matched in estimation.

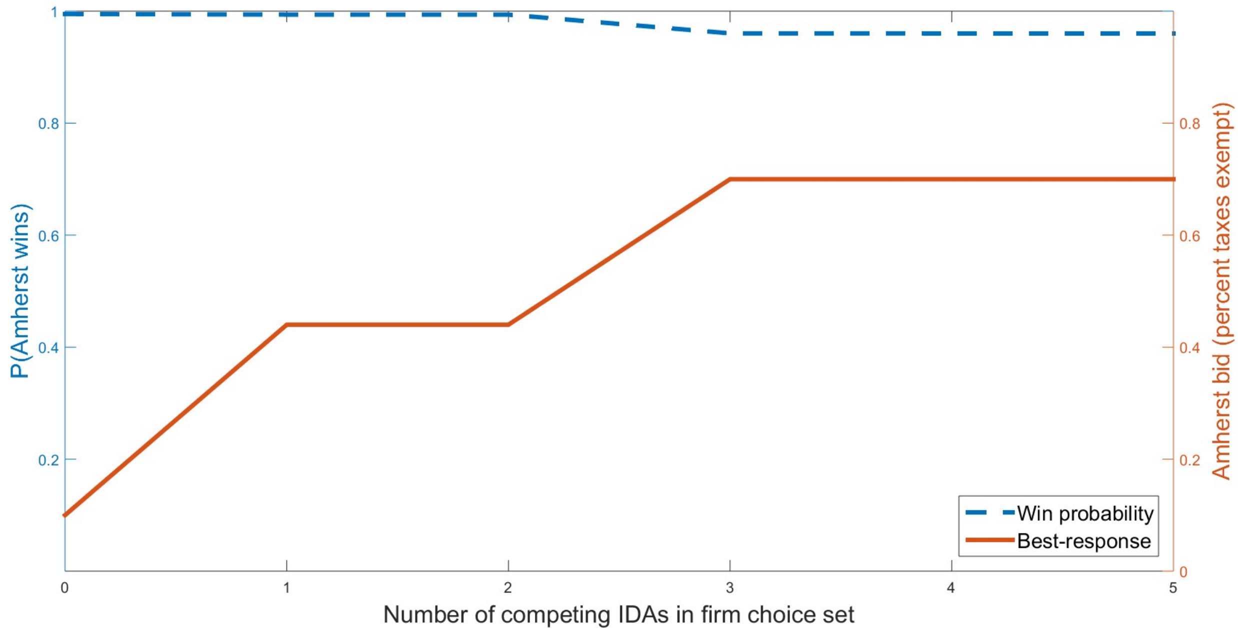
Figure 8: Simulated total exemptions and revenue under counterfactual policies



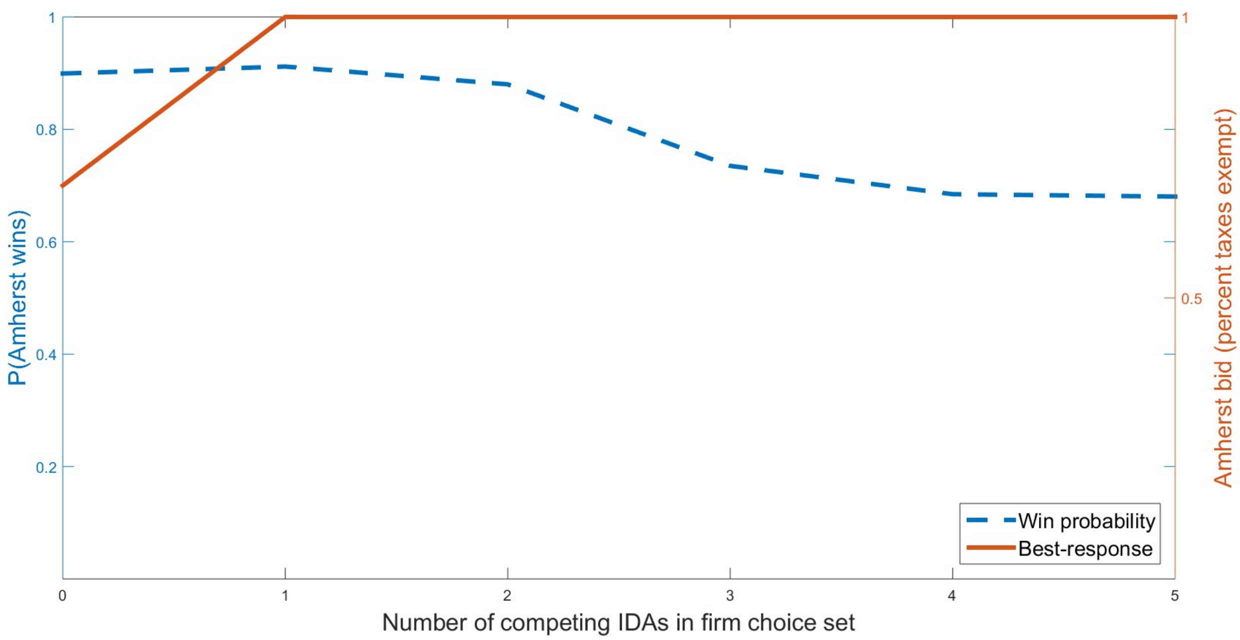
Note: The figure shows total statewide IDA property tax exemptions in 2013 from counterfactual simulations under the full sample model parameter estimates reported in Table 7 for σ=1.66. Actual represents the observed exemptions and revenue. Status quo is a simulation with the current policy regime and serves as a benchmark. Eliminate municipal IDAs leaves only county IDAs active, and Eliminate IDAs simulates the elimination of all IDAs.

Figure 9: Simulations of a firm's arrival with different numbers of nearby IDAs

Panel A: Simulations under estimated parameters



Panel B: Simulations with larger variance σ and smaller disutility of distance β_{dist} in firm profit



Note: This figure simulates a firm arriving with Amherst as its preferred location and plots Amherst's best response bid and win probability as the number of IDAs in the firm's choice set increases. The top panel uses the estimated parameters with σ=1.66, while the bottom increases σ to 6.66 and decreases β_{dist} from 1.63 to 1. The x-axis is the number of IDAs in the firm's choice set. The dashed line and left y-axis show Amherst's win probability, while the solid line and right y-axis show its tax break offer.

Table 1: Summary statistics

Panel A: Agreement level				Panel B: Town level				
Percentile	*Tax exemptions in 2013*	*First year of agreement*	*FTE employment*	*Percentile*	*Tax exemptions in 2013*	*IDAs within 25km*	*Counties within 25 km*	*Percent of establishments receiving exemptions*
10	3,200	1999	5	10	0	1	1	0
50	28,100	2007	40	50	0	3	2	0
75	92,400	2011	111	75	40,000	4	3	0.3%
95	590,000	2013	520	95	1,600,000	8	4	1.9%
Mean	180,000	2007	138.3	Mean	440,000	2.96	1.84	0.4%
N	2,649	2,649	2,261	N	1,096	1,096	1,096	1,096

Note: An observation in Panel 1 is an IDA-firm agreement in 2013. Tax exemptions is the dollars of taxes exempted for a business in 2013. I include only agreements with private, for-profit companies in the sample. FTE employment is self-reported and is not populated for every observation. An observation in Panel 2 is a town. Tax exemptions in 2013 is the total dollars of taxes exempted to businesses located in that town in 2013. Distances between towns and counties are computed as described in Section 2.4 of the main text. The number of establishments in a town (used to compute percent of establishments receiving exemptions) is taken from the ReferenceUSA database.

Table 2: Characteristics of towns with IDAs

	(1) Towns with own IDA	(2) Other towns	(3) Difference
Population	61,964	7,706	54,258***
			(13.3)
Manu. employment percent	5.02	6.28	-1.25***
			(3.19)
Percent white	77.7	93.3	-15.5***
			(11.7)
Percent below poverty line	10.3	7.6	2.79***
			(3.6)
IDAs w/i 25km	5.58	2.78	2.79***
			(8.3)
2006-2010 average unemployment rate	7.13	6.86	0.26
			(0.6)
N	50	1045	

Note: Characteristics of towns with/without their own IDAs. T-statistics appear in parentheses in the differences column. All demographic variables are taken from the 2006-2010 ACS. I drop New York City to avoid skewing means. *** denotes p<.01, ** p<.05, and *p<.1.

Table 3: Observable differences across towns with different values of the instrumental variable

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variable:	*Estabs.*	*Manu. estabs.*	*Estabs. w/i 25*	*Pop.*	*Pop. w/i 25*	*Prop. val.*	*Prop. tax*
Counties in 25 km	-69.9	-4.21	2590.9	-1295	56497	-3357.6	-0.158
[t-statistic]	[1.6]	[1.2]	[1.1]	[1.3]	[1.2]	[.9]	[.5]
Mean DV	489.4	44.8	16,924	10,183	339,217	125,000	29.53
Town observations	1096	1096	1096	1096	1096	1096	1096
County FE	Y	Y	Y	Y	Y	Y	Y

Note: Results from regressions of observable town characteristics on counties in 25 km (the instrument in the main analysis) and a vector of county fixed effects. I drop New York City when computing the mean of the DV. T-statistics appear in brackets Establishment counts come from the 2011 ReferenceUSA data. Population and property value come from the 2006-2010 American Community Survey. Property tax is in mils and is computed as described in Section 2.2 of the Appendix. Distance from town to county is the distance from the town's centroid to the centroid of the nearest town in the county. Standard errors are clustered at the county level.

Table 4: Effect of spatial competition on tax breaks

Panel A: Dependent Variable = 1(any exemptions in 2013)					
	(1)	(2)	(3)	(4)	(5)
	IV Probit	IV Probit	IV Probit	IV Probit	Probit
IDAs within 25 km	.073*	.08*	.159**	.173**	.172***
(S.E.)	(.042)	(.046)	(.069)	(.072)	(.048)
Marginal effect at median	0.025	0.026	0.042	0.057	0.057
Town observations	1096	1096	1057	1057	1057
Population controls	Y	Y	Y	Y	Y
Establishment controls	Y	Y	Y	Y	Y
Geography controls	N	Y	Y	Y	Y
Demographic controls	N	N	N	Y	Y
County fixed effects	N	N	Y	Y	Y

Panel B: Dependent Variable = log(exemptions in 2013+1)					
	(1)	(2)	(3)	(4)	(5)
	IV	IV	IV	IV	OLS
IDAs within 25 km	.339**	.369**	.483**	.522**	.433***
(S.E.)	(.14)	(.14)	(.204)	(.202)	(.129)
Town observations	1096	1096	1096	1096	1096
Population controls	Y	Y	Y	Y	Y
Establishment controls	Y	Y	Y	Y	Y
Geography controls	N	Y	Y	Y	Y
Demographic controls	N	N	N	Y	Y
County fixed effects	N	N	Y	Y	Y

Note: Results from regressions of town tax break activity on the number of nearby IDAs. IV regressions use number of counties within 25 km as an instrument for IDAs within 25 km. Standard errors appear in parentheses. Control variables are listed on page 17 of the main text, and the data source for each is described in Section 2.4. The marginal effect is evaluated at the median predicted probit score. Standard errors are clustered at the county level. In Columns 3-5 of Panel A, some observations are dropped because some counties have either no exemptions or exemptions in every town. *** denotes p<.01, ** p<.05, and *p<.1.

Table 5: Varying radius of the competition measure

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Dependent Variable:			*1(exemptions in 2013)*					*log(exemptions in 2013+1)*		
IDAs within radius	.166**	.173**	0.066	0.036	-0.02	.405**	.522***	0.212	0.063	-0.139
	(.072)	(.071)	(.049)	(.054)	(.051)	(.189)	(.202)	(.148)	(.153)	(.131)
Marginal effect at median	0.052	0.057	0.023	0.000	-0.006					
Radius (km)	20	25	30	35	40	20	25	30	35	40
N	1057	1057	1057	1057	1057	1096	1096	1096	1096	1096
Town controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
County fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Note: This table repeats the IV specifications in Column 4 of Panels A and B of Table 4. Each column represents a separate regression in which the radius of the IDA competition measure varies. I use counties within X kilometers to instrument for IDAs within X kilometers. *** denotes p<.01, ** p<.05, and *p<.1.

Table 6: Heterogeneity by taxing body

	(1)	(2)	(3)	(4)	(5)
		log(exemptions+1) to:			
Dependent variable:	*County taxes*	*School taxes*	*Town taxes*	*State taxes*	*1(Empire Zone)*
IDAs within 25km	.409***	.461**	.506***	.236*	-0.008
(S.E.)	(.158)	(.181)	(.152)	(.127)	(.067)
Town observations	1092	1091	1085	1096	1096
Town controls	Y	Y	Y	Y	Y
County fixed effects	Y	Y	Y	Y	Y

Note: Results from regressions of tax exemptions to different levels of government on the number of nearby IDAs. All regressions use counties within 25 km as an instrument for IDAs within 25 km. County, school, and municipal taxes are property taxes. State taxes are sales taxes. Empire Zones confer state tax credits on firms within their boundaries. Town controls are listed on page 17 of the main text, and the data source for each is described in Section 2.4. Standard errors are clustered at the county level. In the left four columns, some observations are dropped because a small number of towns had negative tax exemptions in a particular category, generally because of an exemption agreement specified in dollars, rather than percentages.

Table 7: Estimates of model parameters

Calibration of σ (error variance in firm profit)	Panel A: Full sample			Panel B: Manufacturing/finance firms			Panel C: Retail/services firms		
	Firm disutility of distance β_{dist}	Town value of firm property K_{prop}	Town value of firm jobs K_{emp}	Firm disutility of distance β_{dist}	Town value of firm property K_{prop}	Town value of firm jobs K_{emp}	Firm disutility of distance β_{dist}	Town value of firm property K_{prop}	Town value of firm jobs K_{emp}
1.33	-1.266	0.237	13,900	-1.560	0.316	81,000	-1.595	0.209	48,000
	(.0466)	(.0057)	(7,667)	(.0309)	(.0097)	(19,300)	(.0201)	(.0097)	(5,175)
1.67	-1.637	0.292	43,500	-1.645	0.312	63,800	-1.355	0.211	38,400
	(.0135)	(.0049)	(8,547)	(.019)	(.0159)	(17,200)	(.0305)	(.0092)	(2,945)
2.5	-1.828	0.325	56,700	-1.802	0.348	55,000	-1.757	0.275	59,900
	(.0237)	(.0099)	(2,319)	(.0232)	(.0083)	(29,400)	(.017)	(.0118)	(4,618)
Number of firm observations	2024	2024	2024	1212	1212	1212	1012	1012	1012

Note: Estimates of the structural model parameters in Equations 5 and 6, obtained by indirect inference. The matched auxiliary model includes the coefficient on the number of nearby IDAs from four estimates of the IV specification reported in Column 4 of Panel B of Table 4, each with a different radius (rather than 25 km) on the nearby IDA variable. β_{tax} in Equation 5 is normalized to -1, and σ, the standard deviation of the error term in Equation 5, is calibrated. The sector-specific estimates were obtained by estimating the model separately for the firms in each sector. Standard errors appear in parentheses. Distance is in kilometers, assessed value in dollars, and employment in FTE jobs. See Section 5 for more details on estimation.

Table 8: Changes in simulated firm location across policy regimes

	(1)	(2)	(3)	(4)
	Percent of firms where the town most likely to win is same across all counterfactuals			
Calibration of σ (error variance in firm profit)	*Base parameters, full sample*	*Sector specific parameters, full sample*	*Sector specific parameters, MF sample*	*Sector specific parameters, RS sample*
1.33	82.1	85.7	85.8	85.5
1.67	85.4	86.1	86.3	85.9
2.5	88.1	88.5	89.2	87.6

Note: Statistics on the number of firms that locate in the same town across all counterfactual simulations under the parameter estimates reported in Table 7. Rows show the calibrated value of σ, the standard deviation of the error in firm profit, while the columns indicate the sample and parameter estimates used in simulations. The base parameters, full sample column shows results from simulations with all firms and full sample parameter estimates. Sector specific parameters, full sample shows results from simulations with all firms, but now applying the appropriate sector-specific parameters to each firm. The sector specific, MF sample column uses only manufacturing/finance firms and the parameters estimated from that sample, while the sector specific RS column does the same for retail/services firms.

Table 9: Results from model with heterogeneity in town valuation

Panel A: Comparison to base model

	Firm disutility of distance β_{dist}	Town value of firm property K_{prop}	Town value of firm jobs K_{emp}	Heterogeneity in town valuation β_{pov}	*Simulated total 2013 exemptions, status quo*	*Simulated total 2013 exemptions, county IDAs*	*Percent of firms with same most likely location across ctrfls*
Base model	-1.637	0.292	43,500	NA	190.8M	136.1M	85.4
Model with heterogeneity	-1.362	0.282	8,340	1.11	200.8M	148.5M	84.5

Panel B: Town surplus from model with heterogeneity

	Status quo	*No town IDAs*	*No IDAs*
Average winning town's valuation of a firm	$5.91M	$5.90M	$5.86M
Average total tax break to a firm	$1.03M	$703,000	0
Average net town surplus from a firm	$4.88M	$5.20M	$5.86M

Note: Panel A compares structural parameter estimates and counterfactual simulation results under the base model and the model with heterogeneity in town valuation of firms. The base model uses Equation 7 for valuations, while the other uses Equation 8, in which a town's valuation of a firm depends on its poverty rate. Both are estimated with σ, the standard deviation of the error term in firm profit, calibrated to 1.66. Distance is in kilometers, assessed value in dollars, and employment in FTE jobs. For more detail on the estimation process, see Section 5. Panel B shows town surplus and tax breaks from simulations of three policy regimes under the model with heterogeneity. The top row shows the average valuation for a firm in the town where it locates. Average total tax break is dollars over the course of the entire multi-year agreement. Average net surplus is the valuation minus the total tax break.

Appendix

This appendix contains further details about the exercises in the main text. Section 1 contains more information about IDAs and other forms of business tax breaks in New York. Section 2 describes data sources and the data construction process in more detail. Section 3 provides further information on the model and its estimation.

1 IDA details

IDAs are generally operated by a board of 3-7 people, who are appointed by the local government of the jurisdiction the IDA represents. In some cases, the board members are volunteers, but they are often paid, especially at more active IDAs. IDAs generate revenue from application and operating fees, returns on their properties and investments, and state subsidies and grants.

The legal process for IDA incentives that is somewhat convoluted. Properties owned by IDAs are exempt from many forms of taxes—property, mortgage granting, sales taxes—and IDAs are also able to issue tax-free financing. IDAs pass these exemptions onto projects they support in a variety of ways. In one common arrangement, a company transfers the title to a property to the IDA, the IDA leases the property to the company at no cost, and then the IDA transfers the title back to the company at the conclusion of the project. Since the IDA technically owns the property, no taxes are due while the IDA holds the title. However, IDAs will usually require businesses to agree to a schedule of Payments in Lieu of Taxes (PILOTs) equal to some percentage of the property taxes that would normally be due on the property. PILOTs are then distributed between the local, school, and county governments, but not to the state government. Another common arrangement is for IDAs to issue debt on behalf of companies, use the proceeds to buy a property, and then lease the property to the company at a nominal rate.

In addition to tax exemptions, IDAs may also confer state or federal income tax exemptions on bonds issued by a firm. Interest on these bonds is exempt from income taxes, enabling firms to offer lower interest rates and obtain cheaper financing. There is a statewide limit on how many bonds may receive federal exemptions from IDAs, but no such limit exists for state tax exempt bonds.

While IDAs are the major agents for local economic development in New York State, there were a variety of other tax incentive programs active during the sample period. The three largest by far are the Brownfield Cleanup Program, the Empire State Film Production Credit, and the Empire Zone program. The Brownfield program encourages the redevelopment of old industrial sites ("brownfields") and provided about \$500 million in state tax credits in 2013. The film production credit provided \$380 million in state tax credits and sales tax exemptions in 2013. While the Empire Zone program was closed to new entrants in 2010, in 2008 it provided tax credits totaling nearly \$600 million to firms located in blighted areas.

A crucial difference between these programs and IDAs is that they primarily provide credits against state taxes, whereas IDAs mainly offer exemption on local taxes. Additionally, these programs restrict which firms may receive exemptions—Brownfield credits can only be given to firms rehabilitating old industrial sites, Empire Zone credits may only be given to firms in blighted areas, and the film credits only benefit one highly specialized industry. Local officials have less discretion in administering these tax credits, and evidence in Table 6 of the main text suggests that they do not compete on this margin,

2 Data

2.1 Variable Construction

Most variables I take directly from the data sources described in Section 2.3 of the main text, but some require modification before being used in the analysis. In order to generate demographic information for towns in New York, which are not a standard Census geographic level, I aggregate Census block group data, linearly interpolating when borders of block groups do not align with borders of towns. In order to generate town-level information on IDA agreements, I simply collapse the main IDA data by town.

I modify several firm-level variables to facilitate the estimation of the structural model. First, I set the year of the firm's arrival to two years after its approval date. This appears to be the modal delay in the data (relatively few projects receive exemptions sooner than two years after the date the agreement is signed) and helps identify the project's cohort of arriving firms in the ReferenceUSA data.

Second, I map the firm sectors provided by IDAs into sectors consistent with the NAICs codes in the ReferenceUSA data. I map Wholesale Trade and Retail Trade into the retail sector; Finance, Insurance, and Real Estate into the finance sector, Manufacturing into the manufacturing sector, and Services and Construction into the services sector. This mapping is inexact in some cases, and I use project descriptions provided by the IDAs to help determine the appropriate classification.

Third, I prepare project property values and number of employees for the estimation. The number of full-time equivalent number of employees at a location is reported directly in the data. I impute assessed property values using before-exemption property tax liability and tax rates.[1] While most projects have both of these variables, a small percentage are missing employment. I use property value to impute employment in these cases. For example, for a manufacturing project that has a property value but is missing employee information, I regress number of employees on property value for manufacturing projects that contain both values and use the estimates to predict employees for the project that has only a property value recorded.

Since employment and assessed property value fluctuate, I have to make assumptions about the level of employment/property value that IDAs consider when forming their valuations of a firm. This may be especially difficult when projects are in their early years and may not be fully built or at full employment. For a project that was active in both 2008 and 2013, I take employment and property value to be the maximum observed. For projects that were at least five years old in 2008 and were not active in 2013, I take employment and property value to be what was observed in 2008. Finally, for projects that were active in only one of 2008 or 2013 and were less than five years old when observed, I take a more complicated approach. First, I compute the median growth rate in property value and employment from 2008 to 2013 for projects that were less than five years old in 2008 and still active in 2013. Then, for a given observation, I multiply the observed property value/employment by

[1]Since, for reasons described in Section 2.2 of the Appendix, county tax rates are the most reliable, I use county tax rates and liabilities to compute assessed values whenever possible. For about 10% of observations, either the county tax rate or liability is 0, and I use the municipal values in these cases.

the median observed growth rate of that variable, prorated according to how old the project was at the time of observation. For example, for a project that was two years old in 2013, I multiply its observed property value by the median property value growth multiplied by .6 to arrive at its final property value.

Fourth, in some agreements, exemptions apply to the taxes on only a portion of the property value.[2] For example, if a firm renovates a building, it might receive exemptions only on the increase in assessed value from the renovation, but not on the original value of the building. Only 12% of agreements in 2008 and 17% in 2013 had such arrangements in which the exempt portion of the assessed value was less than 80% of the full assessed value. Because it's hard to predict what percent of project value would be exempted in different locations and the vast majority of projects receive exemptions on close to the full assessed value, I assume in the model that exemptions always apply to the full assessed value.

Finally, I compute an average property rate for each town. This computation is somewhat complicated, and I describe it separately in the next subsection.

2.2 Property tax rates

To compute the average property tax rate in a town, I first pull the full-value rates[3] for each taxing jurisdiction from New York's Overlapping Property Tax Table. Counties, schools, municipalities, and special districts may all levy property taxes on a given parcel. Because some school districts charge different rates in different municipalities, I average these rates to arrive at a single number per district. These tables include the average rate for special districts in a town in the town tax rate. Data is available to compute these rates for 2008-2013

Second, because the overlapping tax tables average together the residential and non-residential rate, I manually collect the non-residential rate for the roughly 100 taxing jurisdictions that collect different taxes on different types of property. These tax rates are not stored in a centralized location and are generally only available for the current year

[2]This is similar to the tax increment financing structure frequently used in other areas of the country.

[3]Full-value rates are adjusted to represent mils per market value of property. Some towns also report rates as mils per assessed dollar of property, where their assessed value is a proportion of market value.

on town websites. I was able to collect both the rates and the non-residential/residential ratio for about 80% of the jurisdictions, and I assume that the remaining 20% have a non-residential/residential ratio equal to the average over the jurisdictions whose data I was able to collect.

The above two steps leave me with a non-residential tax rate for each taxing jurisdiction. Next, for a given town, I compute the average county, school, and village non-residential taxes according to the percent of the town's land area that is in a given county/district/village. Recall that I use towns and a small number of large villages[4] as my sample of municipalities. When I include a village as a separate observation, I consider the town the village is in to be not the full town, but the town less the land area taken by the village. I thus do not include these villages' tax rate in their containing town's average tax rate. For small villages which I do not include as separate observations, I simply average the village tax rate over the town according to land area.

Finally, I sum a town/large village's average non-residential tax rates for all jurisdictions collecting tax and arrive at an average property tax rate for a given year. I compute these averages for 2008 and 2013 and take them as the town tax rate in that year.

These property tax rates serve two main purposes in this paper. First, they help impute assessed values, as described in Section 2.1 of this Appendix. For imputing assessed values, I need separate rates by taxing jurisdiction in 2008 and 2013. Because the county tax rate is easier to pin down than school district rates or village rates that may be different in different parts of the town, I use county taxes in the imputation whenever possible.

Second, property taxes enter the firm's objective function in the model, where I need a firm's expectation of the average property tax rate in a given location, which is more complicated. Since property taxes are stable over time,[5] I take the average of the rates in 2008 and 2013 to arrive at the rate a firm considers.

[4]Villages are subsets of towns in New York State. Most are very small, with only a few hundred residents.
[5]At least over the 2007-2014 period for which I have data.

2.3 Sample restrictions

As described in Section 5.2 of the main text, I apply a number of restrictions to construct the sample of projects used in model estimation. Because these restrictions shrink the size of the sample, I utilize the 2008 data in addition to the 2013 data. This enables me to simulate more firm arrivals and match both 2008 and 2013 moments. After applying filters, I am left with about 1800 projects in each of 2008 and 2013.

Because IDA projects last multiple years, I have to be careful to not count projects that are in both the 2008 and 2013 data as separate observations. I am able to match about half of the 2008 projects to the 2013 data, enabling me to simulate their arrival once and come up with exemptions for both 2008 and 2013. About a third of 2008 projects expire before 2013. I can simulate these firms and assume that they do not receive exemptions in 2013. The remaining 15% of 2008 projects do not expire and do not match any projects in the 2013 data. This may occur because the firms go out of business,[6] because the agreements are retracted or renegotiated under a different name, or because of data errors or changes in project descriptions. I drop these agreements. There are also a small amount of agreements (8%) in the 2013 data that list a start year prior to 2008 but do not appear in the 2008 data. I also drop these agreements, which likely represent errors in record keeping, leaving 2,224 observations in the final sample.

3 Model

3.1 Model with County IDAs

The model presented in the main text is slightly simplified, as I discuss only towns, rather than town and county IDAs. While I treat town IDAs identically to how I describe towns in the text, county IDAs have a more complicated problem, as they may offer subsidies and care about welfare in a number of towns. I assume that for each arriving firm, they offer a uniform exemption for locating in any town in the county that does not have its own IDA. Each town in the county draws a value for the firm, and the county IDA chooses a uniform

[6] Bear Stearns disappears from the data, for example.

exemption to maximize the expected value among its towns. County c then faces a very similar objective function to town IDAs:

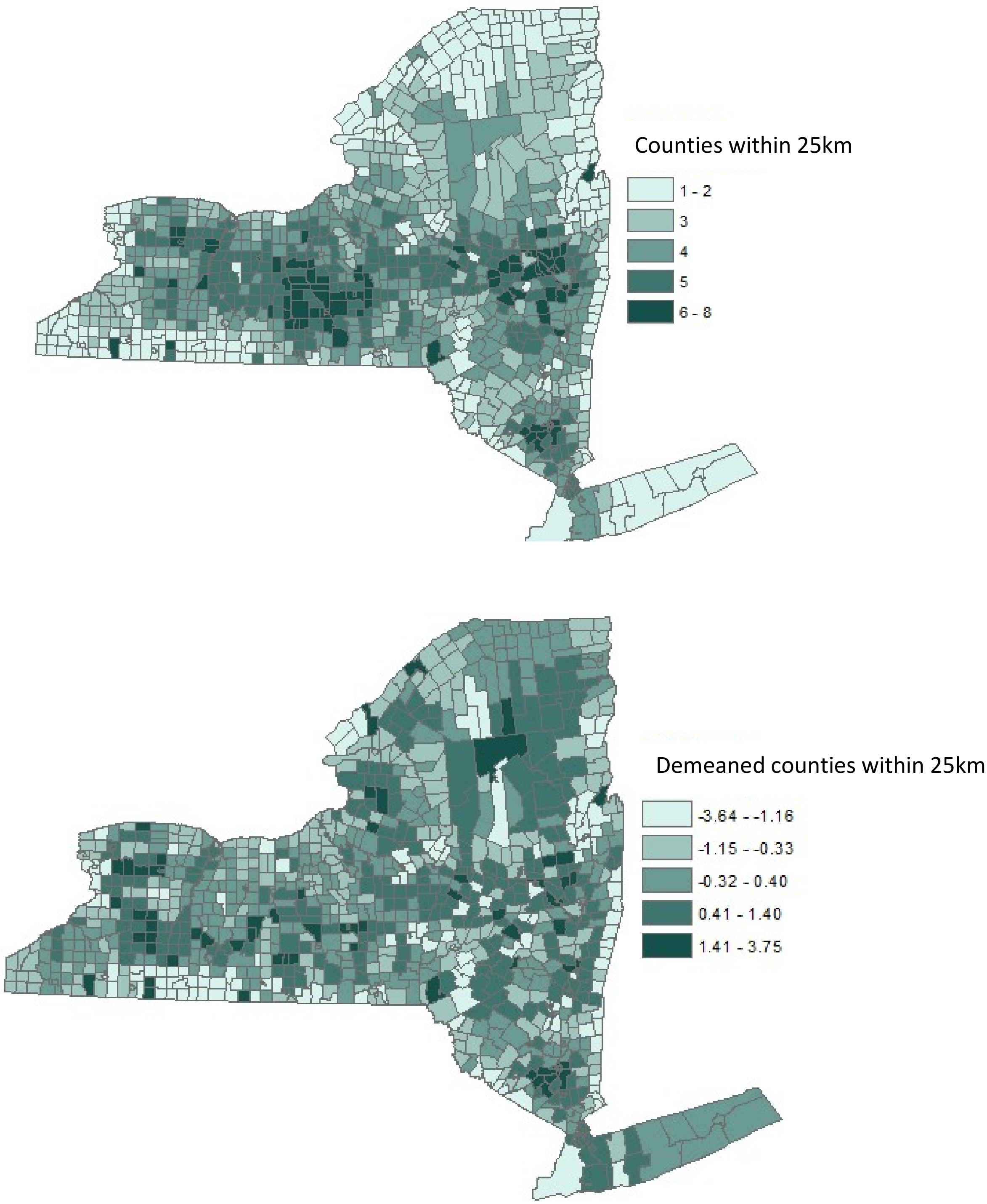
$$E(V_{fc}|b_{fc}, b_{f(-c)}) = \sum_{i \in c} (P(win_{fi}|b_c, b_{-c}) * v_{fi}) \tag{1}$$

where b_{fc} is the exemption offered in each town.

3.2 Model implementation

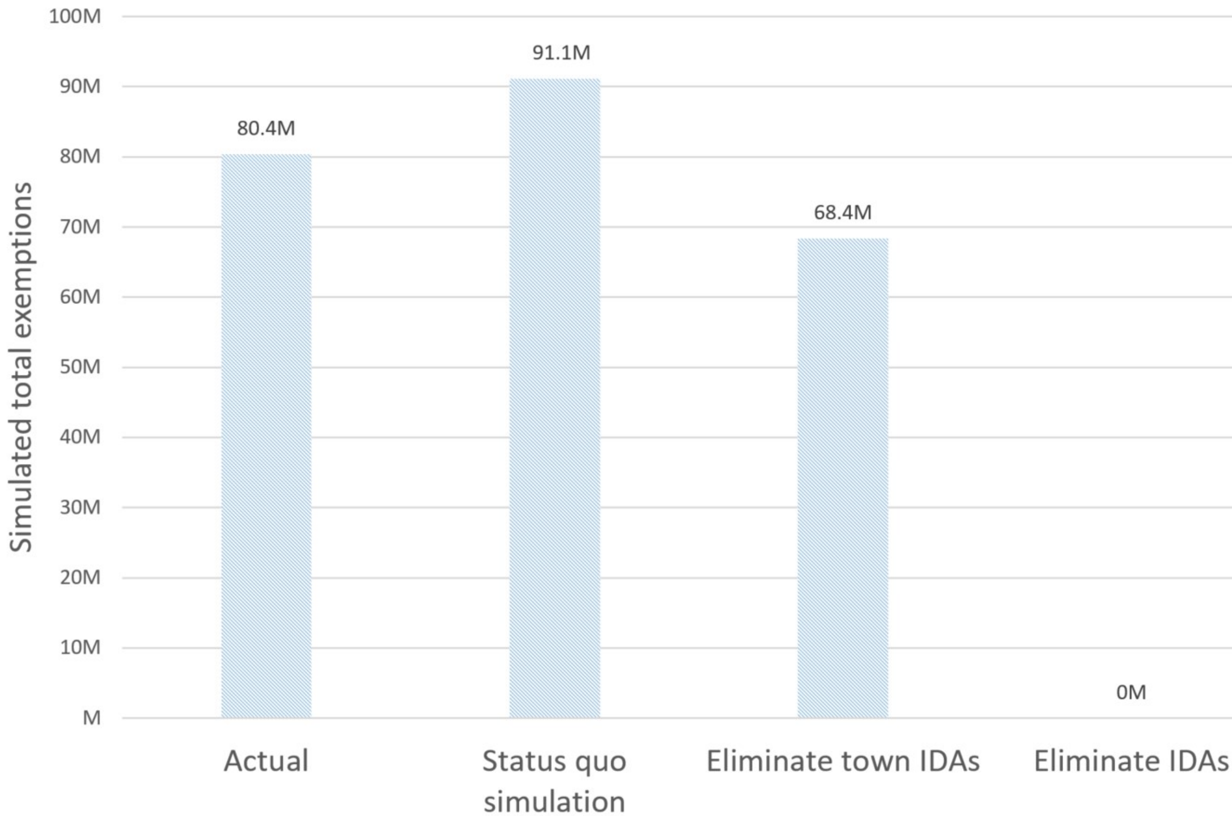
Section 5.2 of the main text provided an overview of the algorithm I use to estimate the structural parameters of the model. I implement this procedure using the Optimization Toolbox in Matlab. The major challenge of the estimation is ensuring that a solution is a global optimum, rather than a local optimum. For each specification that I estimate, I first run a large, coarse grid over the parameter space to provide some idea of the shape of the objective function. I then run a hybrid simulated annealing/pattern search algorithm from three randomly chosen starting points. This hybrid algorithm simply runs a simulated annealing search followed by a pattern search, taking the solution to the annealing search as the starting point for the pattern search. I confirm that searches using these diverse starting points converge to very similar parameters. I take the solution with the lowest distance metric as the parameter estimate for a given specification. Finally, I compare the distance metric associated with the parameter estimate to distance metrics on the coarse grid and confirm that no other parts of the grid yield a smaller distance metric. I compute standard errors according to the standard sandwich formula with numerically simulated derivatives.

Appendix Figure 1: Counties within 25km



Note: The number of counties within 25 kilometers of towns in New York State. The boxes represent towns, colored according to the number of counties within 25 kilometers. The top panel uses the raw number of counties, showing the variation that would drive estimates without county fixed effects. The bottom panel demeans at the county level, showing the variation driving the estimates with county fixed effects.

Appendix Figure 2: Counterfactual exemptions for retail and services sample



Note: The figure shows total statewide IDA property tax exemptions in 2013 from counterfactual simulations using the retail/services subsample and retail/services parameter estimates reported in Table 7 with σ=1.66. Actual represents the observed exemptions and revenue. Status quo is a simulation with the current policy regime and serves as a benchmark. Eliminate town IDAs leaves only county IDAs active, and Eliminate IDAs simulates the elimination of all IDAs.

Appendix Table 1: Selectively dropping areas of the state

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent Variable:	*1(exemptions in 2013)*				*log(exemptions in 2013+1)*			
IDAs within 25 km	.144**	.131**	.091**	0.068	.401**	.523**	.438***	.336*
	(.056)	(.063)	(.044)	(.051)	(.178)	(.222)	(.164)	(.182)
Marginal effect at median	0.046	0.044	0.031	0.026				
Dropped area	NYC Metro	Albany	Buffalo	Upstate	NYC Metro	Albany	Buffalo	Upstate
N	897	1037	1047	905	897	1037	1047	905
Town controls	Y	Y	Y	Y	Y	Y	Y	Y
County fixed effects	Y	Y	Y	Y	Y	Y	Y	Y

Note: This table repeats the IV specifications in Column 4 of Panels A and B in Table 4. Each column represents a separate regression in which certain areas of the state are selectively dropped. *** denotes p<.01, ** p<.05, and *p<.1.

Appendix Table 2: Alternative specifications

	(1)	(2)	(3)	(4)
Specification:	IV	IV Tobit	IV	IV
Dependent Variable:	*1(any exemptions)*	*log(exemptions + 1)*	*Inverse hyperbolic sine (exemptions)*	*% establishments receiving exemptions*
IDAs within X km	.045***	1.43**	.572**	.0012***
	(.018)	(.543)	(.223)	(.0005)
Mean DV	0.363	4.26	3.96	0.0041
N	1096	1057	1096	1096
Controls	Y	Y	Y	Y
County fixed effects	Y	Y	Y	Y

Note: This table shows several alternative specifications for the regressions reported in Table 4. Column 1 shows results from a linear probability model. Column 2 shows a tobit specification. Column 3 uses the inverse hyperbolic sine of exemptions rather than log(exemptions + 1). Column 4 uses the percent of establishments receiving exemptions as the dependent variable and, in order to avoid division bias, omits establishment count control variables. In Column 3, some observations are dropped because some counties have either no exemptions or exemptions in every town. I use counties within 25 kilometers to instrument for IDAs within 25 kilometers. *** denotes p<.01, ** p<.05, and *p<.1.

Appendix Table 3: Competition from close distances

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent Variable:		*log(exemptions in 2013+1)*				*log(exemptions in 2013+1)*		
Number of IDAs in competition group	.248**	.334**	0.228	0.297	.434***	.409**	0.233	0.291
	(.104)	(.153)	(.175)	(.208)	(.129)	(.164)	(.169)	(.204)
Competition group	IDAs within 25 km	IDAs within 20 km	IDAs within 15 km	Bordering IDAS	IDAs within 25 km	IDAs within 20 km	IDAs within 15 km	Bordering IDAs
N	1096	1096	1096	1096	1096	1096	1096	1096
Town controls	Y	Y	Y	Y	Y	Y	Y	Y
County fixed effects	N	N	N	N	Y	Y	Y	Y

Note: This table repeats the OLS specification in Column 5 of Panel B of Table 4. Each column represents a separate regression in which the definition of competitors changes. Columns 1-4 do not include county fixed effects, while Columns 5-8 do. *** denotes p<.01, ** p<.05, and *p<.1.

Appendix Table 4: Splitting firms by sector and size

	(1)	(2)	(3)	(4)	(5)
Firm type:	Tradeable	Non-tradeable	Small (FTE<10)	Large (FTE>40)	Very large (FTE>125)
Dependent Variable:	*1(any exemptions)*	*1(any exemptions)*	*1(any exemptions)*	*1(any exemptions)*	*1(any exemptions)*
IDAs within X km	.127*	.137**	0.038	.139*	.147*
	(.073)	(.039)	(.076)	(.071)	(.091)
Mean DV	0.225	0.278	0.198	0.234	0.158
N	995	1057	983	983	818
Controls	Y	Y	Y	Y	Y
County fixed effects	Y	Y	Y	Y	Y

Note: This table shows the effect of competition on exemptions to different subsamples of firms. Each column repeats the IV probit specification from Column 4 of Panel A of Table 4, but with an indicator for whether a town gave a tax break to any firms in a particular category as the dependent variable. Tradeable sectors are manufacturing and finance/corporate office, while non-tradeable are retail and services. Observation numbers change across columns because some counties have no towns granting exemptions to firms in a particular category and are then dropped from estimation. I use counties within 25 kilometers to instrument for IDAs within 25 kilometers. *** denotes p<.01, ** p<.05, and *p<.1.

Appendix Table 5: Nonlinear effects of competition

Panel A: Adding a squared term				
	(1)	(2)	(3)	(4)
Dependent variable:	*1(any exemptions)*	*1(any exemptions)*	*log(exemptions+1)*	*log(exemptions+1)*
Specification:	OLS	IV	OLS	IV
IDAs within 25 km	.056**	.067**	.65**	.754**
(S.E.)	(.024)	(.028)	(.296)	(.324)
IDAs within 25 km squared	-0.002	-0.003	-0.019	-.034
(S.E.)	(.001)	(.002)	(.02)	(.027)
Town observations	1096	1096	1096	1096
Town controls	Y	Y	Y	Y
County fixed effects	Y	Y	Y	Y

Panel B: Including a spline		
	(1)	(2)
Dependent variable:	*1(any exemptions)*	*log(exemptions+1)*
Specification:	OLS	OLS
IDAs within 25 km (1-3)	0.035	0.411
(S.E.)	(.024)	(.275)
IDAs within 25 km (4-6)	.064**	.741***
(S.E.)	(.022)	(.277)
IDAs within 25 km (6-9)	0.028	0.426
(S.E.)	(.053)	(.703)
IDAs within 25 km (9+)	0.003	0.027
(S.E.)	(.032)	(.494)
Town observations	1096	1096
Town controls	Y	Y
County fixed effects	Y	Y

Note: Estimates of the nonlinear effect of competition on tax breaks. IV regressions use number of counties within 25 km and the square of the predicted value of IDAs within 25 km (from the first stage of the regression reported in Column 4 of Panel B of Table 4) as instruments. IDAs within 25 km and IDAs within 25 km are instrumented for. Standard errors appear in parentheses. Control variables are listed on page 17 of the main text, and the data source for each is described in Section 2.4. Standard errors are clustered at the county level. *** denotes p<.01, ** p<.05, and *p<.1.

Appendix Table 6: Changes in simulated firm location across policy regimes

	(1)	(2)	(3)	(4)
	Percent of firms where set of towns with at least 25% chance of winning is same across all counterfactuals			
Calibration of σ (error variance in firm profit)	*Base parameters, full sample*	*Sector specific parameters, full sample*	*Sector specific parameters, MF sample*	*Sector specific parameters, RS sample*
1.33	74.7	82.8	83.2	82.4
1.67	80.9	81.4	82.4	80.1
2.5	81.1	82.5	82.5	82.4

Note: Statistics on the number of firms where the set of towns with at least 25% chance of winning is the same across all counterfactual simulations under the parameter estimates reported in Table 7. Rows show the calibrated value of σ, while the columns indicate the sample and parameter estimates used in simulations. The base parameters, full sample column shows results from simulations with all firms and full sample parameter estimates. Sector specific parameters, full sample shows results from simulations with all firms, but now applying the appropriate sector-specific parameters to each firm. The sector specific, MF sample column uses only manufacturing/finance firms and the parameters estimated from that sample, while the sector specific RS column does the same for retail/services firms.