DO GOVERNMENTS TAX AGGLOMERATION RENTS?

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Abstract

Using the German local business tax as a testing ground, we empirically investigate the impact of firm agglomeration on municipal tax setting behavior. The analysis exploits a rich data source on the population of German firms to construct detailed measures for the communities' agglomeration characteristics. The findings indicate that urbanization and localization economies exert a positive impact on the jurisdictional tax rate choice which confirms predictions of the theoretical New Economic Geography (NEG) literature. Further analysis suggests a qualification of the NEG argument by showing that a municipality's potential to tax agglomeration rents depends on its firm and industry agglomeration *relative* to neighboring communities. To account for potential endogeneity problems, our analysis exploits long-lagged population and infrastructure variables as instruments for the agglomeration measures.

Keywords: agglomeration rents, corporate taxation, regional differentiation

JEL Classification: H73, R12

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1 Introduction

Standard models on interregional corporate taxation predict that capital mobility across jurisdictional borders deteriorates the ability of governments to collect corporate tax revenues. Precisely, it is argued that jurisdictions have an incentive to lower their tax rate in order to attract the mobile capital base which leads to a race-to-the-bottom in corporate tax setting behavior (see Zodrow and Mieszkowski (1986); Wilson (1986)).

This prediction has recently been challenged by the New Economic Geography (NEG) literature which is based on the idea that firms benefit from locating close to other corporations in economic and industry clusters. These agglomeration economies reduce the interregional mobility of capital and allow agglomeration-hosting governments to set a high corporate tax rate without triggering an immediate capital outflow even if capital is in principle highly mobile (see Ludema and Wooton (2000), Andersson and Forslid (2003), Baldwin and Krugman (2004) and Borck and Pflüger (2006)).

Empirical evidence on the relevance of this argument is however scarce at best. Although a small set of papers suggests that the sensitivity of firm location to corporate taxes diminishes in the presence of agglomeration economies (Devereux, Griffith, and Simpson (2007); Brülhart, Jametti, and Schmidheiny (2007); Jofre-Monseny and Solé-Ollé (2008)), the literature has so far largely neglected to assess whether "policy makers [...] effectively seek to tax agglomeration rents, and whether this [agglomeration] effect is strong enough to have a noticeable impact on the evolution of statutory corporate tax burdens" (Brülhart, Jametti, and Schmidheiny (2007)).

Our paper contributes to close this gap and empirically tests for an impact of agglomeration economies on the corporate tax rate choice. We exploit the local business tax rate in Germany (*Gewerbesteuer*) as a testing ground and use a unique data set on the population of German firms to construct detailed agglomeration measures for German communities. Our findings largely confirm the NEG-prediction and suggest that economic and industry agglomerations indeed exert a statistically significant and quantitatively large impact on the local business tax choice.

The paper starts out with a simple theoretical model to receive guidance for the specification of our empirical framework. We derive two hypotheses: Following the reasoning of the NEG literature, the model firstly predicts that corporate *urbanization* and *localization* economies (i.e. corporate benefits from locating close to economic agglomerations and industry clusters respectively, see Rosenthal and Strange (2004)) raise the corporate tax rate chosen by the agglomeration-hosting jurisdiction which thus captures a fraction of the associated corporate agglomeration rents. Secondly, the model shows that the jurisdictions' ability to tax agglomeration rents critically depends on its agglomeration characteristics *relative* to neighboring regions. Precisely, if a neighboring community hosts a comparable economic agglomeration or industry cluster, the community's position to capture the agglomeration rents is alleviated as it does not provide a locational benefit *relative* to its neighbor.[1]

The model predictions are tested using a data set which merges information on the German municipalities' local business tax to measures for economic and industry agglomerations in Germany between 1999 and 2007. The agglomeration measures are constructed based on data for the population of German firms which comprises information on the host municipality, the four-digit industry code and the number of employees. From this data, the urbanization variable is calculated as the overall number of workers in a jurisdiction.[2] To derive a localization measure, we in a first step identify four-digit industries whose localization pattern shows strong spatial clustering in Germany following the approach proposed by Duranton and Overman (2005). According to the concept of revealed preferences, we consider these to be the sectors in which firms benefit from locating close to corporations in the same industry. In a second step, we use this information to construct community-specific localization measures which account for the municipality's number of workers in localized industries and for the localization intensity of the industry.

Our estimation results suggest that both, urbanization economies and localization economies, exert a positive impact on the jursidictions' tax rate choice. The effects are statistically significant, quantitatively large and appear across a wide range of specifications in which we use alternative variables to capture localization economies. Our preferred estimates suggest that doubling the overall number of employees increases the local business tax by around 1.2% while doubling the number of employees in *localized* industries raises the local business tax by around 3.4% on average.

To evaluate the impact of a jurisdiction's relative agglomeration characteristics on

[1]Note that the model thus synthesizes the standard tax competition framework and its NEG modification as it suggests that jurisdictions are only able to tax agglomeration rents if their agglomeration characteristics differ from neighboring jurisdictions. Otherwise, the race-to-the-bottom mechanism is reintroduced despite the agglomeration features.

[2]Our investigation approach largely focuses on corporate rents which accrue from locating close to other *firms*. In robustness checks, we however also test the sensitivity of our results to the inclusion of market-based agglomeration measures which capture the access to consumer markets. This is found to leave our result largely unaffected.

the local business tax choice, we moreover determine tax measures which capture a municipality's *relative* firm and industry agglomeration compared to its geographical neighbors. In the urbanization dimension, the agglomeration measure is calculated as the difference in the number of employees between a considered community and its neighbors, normalized on distance. In the localization dimension, the measure analogously captures employment differences for the set of localized industries hosted by a jurisdiction compared to its neighbors. Our regression results indicate that these relative agglomeration variables are a strong predictor of the jurisdictional local business tax choice and explain more variation in the tax rate than the communities' own agglomeration characteristics.

All our regression results furthermore turn out to be robust against the inclusion of a large set of control variables for differences in primary nature characteristics (e.g. the quality of soil and the proximity to rivers, mountains and the sea), the communities' demographic composition, budgetary situation and public good provision. Moreover, our estimation approach takes into account that neighboring communities may be hit by correlated shocks and that we might face reverse causality problems as the local business tax rate choice may simultaneously affect firm and industry agglomeration in a municipality. To overcome the latter identification problem, we employ an instrumental variable approach which relies on long-lagged historical population data and on historical information on railway connections from the time prior to 1936 when the first local business tax act was passed in Germany.

The paper relates to the literature on agglomeration economies. Empirical contributions in this area stress the positive role of urbanization and localization economies in determining worker productivity (Henderson (1986), Henderson (2003) and Combes, Duranton, Gobillon, and Roux (2007)), wages (Wheaton and Lewis (2002)) and economic growth (Glaeser, Kallal, Scheinkman, and Shleifer (1992), Henderson, Kuncoro, and Turner (1995)). Incorporating these agglomeration economies in a tax competition model predicts that agglomeration rents dampen the mobility of firms and capital across borders which allows governments to set higher tax rates.

However, as mentioned above, the impact of agglomeration economies on the governmental tax rate choice is empirically largely unexplored. Two exception are papers by Büttner (2001) and Charlot and Paty (2007) who determine the effect of urbanization economies in the consumer dimension on the tax rate choice of local jurisdictions. Büttner (2001) analyzes the determinants of the German local business tax for municipalities in the state of Baden-Württemberg and finds that jurisdictions with a larger population tend to set higher local business tax rates. Charlot and Paty (2007) assess the effects of consumer market access on the corporate tax rate choice for French municipalities. They find a positive relationship between the local tax rate and the municipality's market access suggesting the existence of a taxable agglomeration rent. Both papers, however, neglect urbanization and localization economies in the firm dimension and do not account for the importance of relative agglomeration characteristics compared to neighboring communities. Moreover, both papers do not address potential identification problems caused by reverse causality, a problem that we circumvent in our analysis by using an instrumental variable approach.[3]

Our paper is structured as follows: In Section 2, we discuss the main theoretical hypotheses underlying our empirical work. Sections 3 and 4 describe the data set and the estimation strategy. Section 5 presents our main findings. Section 6 concludes.

2 A Simple Theoretical Model

In the following, we construct a simple theoretical model based on Haufler and Wooton (2009) to receive guidance for the specification of our empirical framework. We consider two jurisdictions $i \in \{a, b\}$, each inhabited by l_i workers. Each jurisdiction hosts two industries, a "localized" industry and a numéraire sector.[4] Firms of the localized industry produce a homogeneous good x under imperfect competition using labor as variable input whereas firms in the latter sector produce the numéraire good z under perfect competition using labor as the only input. Contrary to the x commodity which is traded subject to real transport (or administration costs) τ, the numéraire good is traded freely which also ensures the wage rate w to be equalized across jurisdictions. Both jurisdictions compete for a fixed number of k mobile firms from a third region which operate in the x-industry and are willing to invest in either a or b.

In the first stage, each government decides on the level of the business tax rate t_i. The location decision of the k new firms is made in the second stage. Production and consumption occur in the last stage. We solve the game by backward induction and begin with the third stage.

Workers' preferences and demand
Employees in both locations derive utility from consuming both commodities x and z.

[3]Note that our analysis largely focuses on agglomeration economies which arise through the geographical clustering of firms. Nevertheless, our results are unaffected by the inclusion of a control variable for the consumer market access as shown in the analysis.

[4]The precise characteristics of firms in the localized industry will be explained below.

Their preferences which are identical across locations are described as

$$u_i = \alpha x_i - \frac{\beta}{2} x_i^2 + z_i, \quad \alpha, \beta > 0, \quad i \in \{a, b\}. \tag{1}$$

Each worker receives wage income from inelastically supplying one unit of labor to sector x or z. Moreover, we assume that total revenues T_i stemming from local business taxation are entirely redistributed to the workforce residing in jurisdiction i. Hence, each worker's budget constraint can be expressed as $w + \frac{T_i}{l_i} = z_i + p_i x_i$. Solving the representative worker's utility maximization problem and aggregating over all workers yields aggregate market demand X_i for good x in market i, with $X_i = \frac{l_i(\alpha - p_i)}{\beta}$.

Producers

Each entrant incurs fixed and identical costs f which incorporate costs e.g. for finding a suitable location, setting up a production facility, buying sector specific machines or administration costs not further specified in the model. These costs are sufficiently large such that each firm operates at most one production facility. In contrast to Haufler and Wooton (2009) we do not regard jurisdictions to be initially 'empty' but allow for the existence of initial h_i firms in the x industry with industry employment l_{ix}.[5] These already existing firms have made their irreversible location decision in the past and serve both markets from either jurisdiction a or jurisdiction b.

The sizable literature on agglomeration economies indicates various possibilities for introducing agglomeration economies into a theoretical model.[6] Early scholars like Marshall (1890) or von Thünen (1826) formulated different causes for industry agglomeration which result from 'thickly peopled' industrial districts that can be subsumed under the categories - knowledge creation and knowledge processing, sharing of intermediate goods suppliers and sharing a common labor market. Yet in the end, these various agglomeration channels point to the same effect: providing a single firm with a locational (cost) advantage when it locates in close proximity to other firms of the same or other industries. As dealing with the micro-foundations of agglomeration economies would go far beyond this paper, we decided to introduce agglomeration advantages in the most conceivable way.[7] We thereby follow a recent contribution of Konrad and

[5] Strictly speaking $l_{ix} \equiv h_i(\tilde{x}_{ii} + \tilde{x}_{ji})$ where $\tilde{x}_{ii}$ and $\tilde{x}_{ji}$ represent output quantities of an initial firm that would prevail if the k firms and hence jurisdictional competition were absent. We further assume $l_{ix} < l_i$ to ensure that both commodities are produced and the wage is equalized across locations.

[6] Rosenthal and Strange (2004) provide a comprehensive overview of the empirical literature on the sources of agglomeration.

[7] See Duranton and Puga (2004) for a detailed survey on the micro-foundations of agglomeration economies.

Kovenock (2009) and presume that an entrant's set up costs f are lowered if it locates close to these initial h_i producers. For instance, new firms benefit from facilitated access to industry specific transport or communication infrastructure when locating in a jurisdiction with sizable economic activity.[8] The fixed costs for the k new firms then read

$$F_i \equiv f - \gamma l_{ix} - \mu l_i, \quad \gamma, \mu > 0, \quad i \in \{a, b\} \tag{2}$$

where γl_{ix} measures a new firm's benefit resulting from agglomerated employment at the sectoral level ('localization') and μl_i reflects an entrant's advantage from locating in a jurisdiction with large overall employment ('urbanization'). Our modeling approach thereby closely follows the empirical literature on localization and urbanization economies where total employment in a city serves as proxy for urbanization and localization is proxied by industry employment.[9] In the spirit of Brander and Krugman (1983)'s reciprocal dumping model firms non-cooperatively choose quantities for each market separately. Pre-tax operating profit of a firm located in i reads

$$\pi_i = (p_i - w)x_{ii} + (p_j - w - \tau)x_{ji}, \quad i \in \{a, b\}, \quad i \neq j \tag{3}$$

where p_i denotes the sales price on the own market and p_j denotes the price prevailing on the neighboring market. Note that transporting the x good to the other jurisdiction raises marginal costs to $(w + \tau)$ whereas the marginal cost of producing the good for the own market is simply the wage rate w. x_{ii} denotes the quantity sold on market i and x_{ji} denotes the quantity sold on market j by a firm producing in i. Maximizing (3) under consideration of the market demand X_i yields optimal quantities for both markets of a firm located in i

$$x_{ii} = \frac{l_i(\alpha - w + (k_j + h_j)\tau)}{\beta(1 + k + h)}, \qquad x_{ji} = \frac{l_j(\alpha - w - (1 + k_j + h_j)\tau)}{\beta(1 + k + h)}, \tag{4}$$

with $k = k_i + k_j$ and $h = h_i + h_j$, $\quad i \neq j, \quad i, j \in \{a, b\}$.[10] Inserting (4) into the market demand function X_i yields the equilibrium price prevailing on each market

$$p_i = \frac{\alpha + (k + h)w + \tau(k_j + h_j)}{1 + k + h}, \quad i \neq j, \quad i, j \in \{a, b\}. \tag{5}$$

[8] Konrad and Kovenock (2009) introduce agglomeration advantages that result from the existence of old FDI. In particular, a jurisdiction will be more successful in attracting new FDI if it succeeded in attracting FDI in preceding time periods as this lowers the fixed costs for new FDI.

[9] See e.g. early studies on agglomeration economies by Nakamura (1985) and Henderson (1986).

[10] As in Haufler and Wooton(2009) we assume that the cost of transporting x are positive but sufficiently low to ensure that $x_{ji} > 0$ and $x_{ij} > 0$.

Substituting optimal output levels using (4) and prices using (5) into (3) yields pre-tax operating profit of a firm located in i

$$\pi_i = \frac{l_i[\alpha - \omega + (k_j + h_j)\tau]^2}{\beta(1+k+h)^2} + \frac{l_j[\alpha - \omega - (1 + k_j + h_j)\tau]^2}{\beta(1+k+h)^2}, \quad i \neq j, \quad i, j \in \{a, b\}. \quad (6)$$

Locational equilibrium

At the second stage all k new firms decide on where to set up their production facility based on the comparison of after-tax profits in a and b, with $\Pi_i \equiv \pi_i - F_i - t_i$, $i \in \{a, b\}$. Solving the condition for a locational equilibrium $\Pi_i - \Pi_j = 0$ yields the equilibrium number of new firms in jurisdiction i

$$k_i^* = -\frac{\rho(t_i - t_j)}{2\tau^2 L} + \frac{\rho\gamma(l_{ix} - l_{jx})}{2\tau^2 L} + \frac{(\phi\tau + \rho\mu)(l_i - l_j)}{2\tau^2 L} + \frac{k - \theta}{2}, \quad (7)$$

with $i, j \in \{a, b\}$, $i \neq j$, $\rho \equiv \beta(1 + h + k) > 0$ and $\phi \equiv 2(\alpha - \omega) - \tau > 0$. $L = l_a + l_b$ describes the overall number of workers and $\theta \equiv (h_i - h_j)$ the difference in initial firms of jurisdiction i and j. The first term in (7) incorporates the deterring effect of local business taxation. A larger tax rate in i discourages firms from locating in this market. The second and third term suggest that the firms' location decision will however be less affected by differences in tax rates if the respective jurisdiction offers some locational advantage at the sectoral and overall level of economic activity. The equilibrium number of firms in i will therefore be higher the larger the localized sector measured by the number of workers in the x sector and the larger the overall number of workers relative to the competing jurisdiction.[11] Moreover, localization and urbanization advantages as well as differences in tax rates become more important for the firms' location choice as transport costs decline. This is because the opportunity costs of locating in one jurisdiction in response to differences in agglomeration economies or tax rates decline with decreasing transport costs. Finally, allowing both locations to be non-empty at the beginning of the tax game implies that the number of entrants in jurisdiction i will be lower, the higher the number of existing firms in this market as competition in i will be more intense.

Governments

In the first stage of the tax game, governments choose tax rates non-cooperatively to maximize their residents' wage income wl_i and revenues $T_i = t_i(h_i + k_i)$, with $i \in \{a, b\}$.

[11] We therefore account for recent empirical contributions by Devereux et al. (2007), Brülhart et al. (2007) and Jofre-Monseny and Solé-Ollé (2008) on the attenuating effects of agglomeration economies on firms' sensitivity to tax differentials.

Differentiating each government's objective function $W_i = t_i(k_i + h_i) + wl_i$ with respect to its own tax rate yields

$$\frac{\partial W_i}{\partial t_i} = h_i + k_i + t_i \frac{\partial k_i}{\partial t_i} = 0, \quad i \in \{a, b\}. \tag{8}$$

Using k_i^* from (7), the governments' reaction function then reads

$$t_i = \frac{t_j}{2} + \frac{\gamma}{2}(l_{ix} - l_{jx}) + \big(\frac{\tau\phi + \rho\mu}{2\rho}\big)(l_i - l_j) + \frac{\tau^2}{2\rho}(h + k)L, \quad i \in \{a, b\}, \quad i \neq j, \tag{9}$$

with

$$\frac{\partial t_i}{\partial l_i} > 0 \qquad \text{and} \qquad \frac{\partial t_i}{\partial l_{ix}} > 0. \tag{10}$$

In the following we are interested in the effects of increased agglomeration in location i on the government's business tax rate choice.[12] The comparative static results in (10) suggest that both, urbanization (l_i) and localization (l_{ix}), exert a positive impact on jurisdiction i's business tax. This effect arises as firms retrieve rents from locating close to other firms in economic and sectoral agglomerations which reduces the sensitivity of their location choice to business tax increases. Consequently, the corporate urbanization and localization rents become taxable for the jurisdiction's government whose tax rate choice thus rises in the degree of urbanization (l_i) and localization (l_{ix}) within its borders.

On top of that, our model shows that the ability of a government to tax away location rents depends on the jurisdiction's economic and sectoral agglomeration *relative* to the competing jurisdiction. This is formally captured by the comparative static results

$$\frac{\partial t_i^*}{\partial (l_i - l_j)} > 0, \qquad \frac{\partial t_i^*}{\partial (l_{ix} - l_{jx})} > 0, \tag{11}$$

with $i \in \{a, b\}$ and $i \neq j$. The intuition behind this finding is that the larger a jurisdiction's economic and sectoral agglomeration relative to its neighboring jurisdiction, the higher is its relative locational attractiveness for the set of mobile firms. Precisely, if a jurisdiction's agglomeration characteristics by far exceed those of its neighbor, it is extremely unattractive for mobile firms to locate in the foreign jurisdiction. Consequently, the government can set a high tax rate without triggering a firm location

[12]The last term in (9) results from a location-rent effect described in detail in Haufler and Wooton (2009). The intuition behind this effect is that higher transport costs provide a shield against increased product market competition. This allows governments to tax firms at a higher rate if transport costs are high. We consider this effect to be of minor importance for our empirical analysis as we expect transport costs to be low at the subnational level.

decision against its jurisdiction. On the contrary, if the economic and sectoral agglomeration characteristics of the jurisdictions are comparable such that they can be regarded as close substitutes, each government has only limited taxing power since increases in the business tax induce mobile firms to locate in the neighboring jurisdiction with comparable agglomeration characteristics.

Our model can thus be considered to synthesize the standard tax competition framework and its NEG modification as it suggests that jurisdictions are only able to tax agglomeration rents if their agglomeration characteristics in the economic and sectoral dimension are large relative to neighboring entities. If jurisdictions in contrast observe similar agglomeration features, the race-to-the-bottom in corporate tax rates may be reintroduced in the model despite the presence of agglomeration rents.

Summarizing, our analysis predicts a positive effect of urbanization and localization economies on the tax rate choice and stresses that it is not only the jurisdiction's own agglomeration measures which are decisive for the corporate tax decision but also the relative position compared to other jurisdictions. In the following, we will bring these hypotheses to the data.

3 Data

Our testing ground is the German local business tax which is set autonomously by the approximately 11,000 German municipalities. To determine how economic and industry agglomerations affect the local business tax choice, we exploit detailed micro data on the population of German firms to construct measures for economic agglomerations and industry clusters.

Our final data contains information for the years 1999 to 2007. The observational unit is the municipality per year. We restrict our analysis to communities located in Western Germany as communities in the East German states (which joined the Federal Republic of Germany in 1990) were subject to several structural reforms which changed their geographical borders within our sample period.[13] This leaves us with a total of $60,646$ observations for 6,776 West German municipalities between 1999 and 2007. In the following, we will briefly describe the local business tax variable (Section 3.1), the construction of our agglomeration measures (Section 3.2) and the control variables included in the analysis (Section 3.3).

[13]Nevertheless, we find largely comparable results to the ones presented in this paper if we include the East German municipalities in the analysis.

3.1 The Local Business Tax Rate

The dependent variable in our empirical analysis is the local business tax rate which is set at the municipality level and significantly contributes to the tax burden on firms operating in Germany. The local business tax is a tax on business earnings which is uniformly levied on all incorporated and non-incorporated firms located within the communities' borders. Tax discrimination between firms which operate in different industries is not possible (see e.g. Büttner (2003) for an in-depth description of the business tax legislation).

The information on the local business tax rate is obtained from the German Federal Statistical Office. As reported in Table 1, the average tax rate set by the communities in our sample is determined with 16.6% whereas the variable exhibits a considerable spread across observations between tax rates of 0% and 25%.

3.2 Construction of the Agglomeration Measures

One major challenge for our analysis is the construction of measures that capture the presence of economic and industry agglomerations within a municipality's borders. To do so, we exploit a comprehensive and detailed data set on the population of German firms which is provided by the German Employment Agency ("Bundesagentur für Arbeit") and is available for the years 1999 to 2007. The data includes information on the firms' industry classification at the 4-digit level, the number of employees (subject to social security payments[14]) and the firms' host community.

- Table 1 about here -

Urbanization Measures

To capture the general economic activity in a community and the associated urbanization rents (see Rosenthal and Strange (2004)), our analysis defines an urbanization measure denoted by U_{it}. In line with previous studies, our baseline estimations approximate urbanization economies by the municipality's number of employees, formally defined as $U_{it}^{o} = EMP_{i,t}$ with $EMP_{i,t}$ being the number of workers that are employed

[14]In Germany, only workers employed in minor contracts (earning less than 400 Euros per month) are not subject to social security contributions.

in municipality i at time t.[15]

Our discussion in Section 2 moreover suggests to construct a relative urbanization measure that captures the community's agglomeration size compared to neighboring jurisdictions. Building on the idea that firms have geographical location preferences, we define neighbors according to the inverse of their distance to the considered community (see also Carr, Markusen, and Maskus (2001) and Büttner (2003))[16] and hence derive a relative urbanization measure which reads

$$U^r_{i,t} = \sum_{j=1}^{J} \left(\frac{EMP_{i,t} - EMP_{j,t}}{DIST_{i,j}} \right), \quad i \neq j, \tag{12}$$

whereas $EMP_{i,t}$ ($EMP_{j,t}$) depicts the overall number of employees in the considered jurisdiction i (neighboring jurisdictions j) in year t and $DIST_{i,j}$ stands for the geographic distance between the two jurisdictions.[17] The higher the value of the similarity measure $U^r_{i,t}$, the larger the number of workers that the considered municipality hosts relative to neighboring jurisdictions.

Note that the construction of this relative agglomeration index is guided by our theoretical analysis in Section 2 which suggests that neighboring jurisdictions are location *alternatives* for firms. In principle, it might also be the case that corporations (and in consequence their host communities) benefit from firm and industry agglomerations in neighboring municipalities. However, as previous findings in the literature suggest that urbanization (like localization) economies have an extremely limited geographical scope of a few kilometers at most (see Rosenthal and Strange (2004), Viladecans-Marsal (2004), van Soest and van Oort (2006), and Jofre-Monseny (2009)), we consider the former effect to prevail. Nevertheless, to test the sensitivity of our results, we also recalculated the index dismissing very close neighboring communities from the index construction which derives comparable results to the ones reported in Section 5. Moreover, our empirical analysis will account for the possibility that firms benefit from locating close to *large consumer markets* (see Section 5).

Localization Measures

In a second step, we construct measures for localization economies, denoted by $L_{i,t}$.

[15]In robustness checks, we reran the analysis using the number of firms as urbanization measure and found comparable results.

[16]Precisely, this corresponds to the intuitive presumption that immediate neighbors are more likely to be relevant competitors for firms and capital than more distant jurisdictions.

[17]Note that *all* other German communities $j \neq i$ are considered for the construction of $U^r_{i,t}$ whereas their relative importance as competitors of jurisdiction i is captured by the distance normalization.

In doing so, we acknowledge that firms may derive extra-benefits from locating close to other corporations in the same industry. These localization economies are likely to be sector-specific, i.e. not necessarily firms in every sector profit from locating close to other corporations in the same industry. We thus exploit our micro data on the population of German firms to identify 4-digit industries in Germany which exhibit strong geographical clustering at small distances. Following the notion of revealed preferences, we expect that those firms which belong to industries that cluster in space derive significant benefits from locating close to corporations in the same industry.

Clustered 4-digit sectors are identified based on a methodology developed by Duranton and Overman (2005) (in the following abbreviated by DO). Broadly speaking, the DO-approach assesses whether industrial location patterns (conditional on the general economic agglomeration) significantly deviate from randomness. The formal methodology is sketched in Appendix A whereas a more detailed description of the approach as well as of the results to this exercise can be found in a companion paper (Koh and Riedel (2009)). Abstracting from industries which are clearly not expected to show geographical localization patterns (as e.g. public libraries, retail companies etc.), the DO approach reports that the location pattern of 78% of the remaining German manufacturing and service industries shows statistically significant localization at *any* distance. As localization rents are plausibly only taxable if firms profit from agglomerating at *small* distances within a jurisdiction's borders[18], we identify the sub-set of industries which are significantly agglomerated within the boundaries of German jurisdictions.[19] This holds for 73% of the industries included in the analysis. One merit of the DO approach is that it also allows us to derive an index for the *intensity* of an industry's agglomeration pattern (denoted by DO_m in Appendix A). For the German industries in our sample the index varies between 0 and 0.134, with larger values indicating stronger agglomeration patterns. Table 2 reports the list of four digit industries which are found to be strongly localized in the sense that they exhibit a DO index above the mean of the index distribution.

[18]If an industry is for example significantly agglomerated at a distance of 50 kilometers, then firms appear to profit from being sufficiently close to each other but not necessarily from locating within the same community. This does not allow any of our geographically small communities to tax the associated agglomeration rent as the firms are expected to be indifferent at which precise community within a certain distance radius to locate.

[19]In terms of the DO approach, these industries are agglomerated at a distance of 0 kilometers as we cannot identify the exact geographic location of firms within one community and the geographical distance of firms located in the same community is consequently determined with zero kilometers.

From this information, we define a localization variable which comprises the community's number of workers employed in localized industries $L^{o1}_{i,t} = \sum_{m=1}^{M} EMP_{i,m,t}$ with $EMP_{i,m,t}$ indicating the number of employees in community i at time t in the localized industry m.

Moreover, following the idea of revealed preferences, the corporate agglomeration benefits are expected to be larger the stronger the observed localization pattern in an industry. This suggests to construct localization measures which link information on the number of employees in a localized industry with information on the industry's localization pattern. To do so, we follow two approaches. Firstly, we construct a variable which recalculates $L^{o1}_{i,t}$ accounting only for strongly localized industries with a DO index above the mean of the distribution. Secondly, we define a variable $L^{o2}_{i,t} = \sum_{m=1}^{M} EMP_{i,m,t} \cdot DO_m$ which multiplicatively links the number of localized employees and the localization intensity of the industry. The latter reflects an intuitive complementary relation between the two measures, with increases in the number of employees exerting a stronger effect on the tax rate choice the larger the agglomeration intensity, and vice versa.

Following our theoretical predictions, we moreover determine a localization measure for the community's industry agglomeration relative to neighboring jurisdictions. Precisely, we define the variable $L^{r}_{i,t}$ as the difference of a jurisdiction's number of employees in a localized industry compared to its neighbors. Summing up over all localized industries reads

$$L^{r}_{i,t} = \sum_{j=1}^{J} \sum_{m=1}^{M} \left(\frac{EMP_{i,m,t} - EMP_{j,m,t}}{DIST_{i,j}} \right), \quad i \neq j \tag{13}$$

whereas $EMP_{i,m,t}$ ($EMP_{j,m,t}$) again depicts jurisdiction i's (the neighboring jurisdiction j's) number of employees in industry m at year t and $DIST_{i,j}$ stands for the distance between the two jurisdictions. The higher this measure, the larger are the localization characteristics of the considered community compared to its geographical neighbors. Again, we additionally account for the agglomeration intensity of the localized industry by recalculating the relative agglomeration measure $L^{r}_{i,t}$ for the subgroup of strongly localized industries with a DO index above the mean of the distribution.

As the distribution of the urbanization and localization measures is strongly skewed, our empirical analysis employs a logarithmic transformation of the variables. To avoid losing observations with non-positive values, we follow previous studies (e.g. Alesina, Barro, and Tenreyro (2002)) and define the logarithm of the distance to the variable's minimum value plus a small constant. Formally, log U^{r}_{it} is thus defined as $\log U^{r}_{it} =$

$\log[U^r_{it} + \min(U^r_{it}) + \eta]$, with η being a small positive constant. Analogous logarithmic transformations are employed for L^{o1}_{it}, L^{o2}_{it} and L^r_{it}.

- Table 2 about here -

Descriptive statistics for the defined localization and urbanization measures are depicted in Table 1. All variables exhibit a considerable variation across observations. Moreover, as indicated in Table 3, the constructed agglomeration measures are positively correlated (with correlation coefficients between 0.498 and 0.831). Table 3 moreover points to a positive correlation between the agglomeration measures and the local business tax choice. In the following section, we will assess whether this pattern prevails in an in-depth econometric analysis.

3.3 Control Variables

Last, we augment our data by information on various municipality characteristics which are used as control variables in our analysis. Precisely, we include variables for first-order nature differences between the jurisdictions, comprising data for the soil quality (precisely, categorial data on the fertility, erosion and slope of the soil, published in the European Soil Database) and the location of a community at rivers, lakes, the sea and the mountains (obtained from the Bundesamt für Kartographie und Geodäsie).[20]

- Table 3 about here -

Moreover, we account for information on the inhabitants' average net income and the community's financial situation as measured by the deficit per capita and the grants per capita received through the German income redistribution scheme. Furthermore, we add information on the level of public good provision by including variables on infrastructure quality, precisely the number of railway stations, airports, seaports and high-way connections. We moreover include information on public good preferences

[20] As the data on soil fertility and erosion is available in categorial format, we add a full set of dummy variables for the categories to our analysis. Analogously, the information on the geographical location of communities at rivers, lakes, the sea and mountains is captured by a set of dummy variables. To save on space, the descriptive statistics for the nature geographics are not reported in the paper but are available from the authors upon request.

and financing needs as indicated by the fraction of the community's population aged below 14 and above 65, the unemployment rate and (in robustness checks) the political party of the municipality's mayor. As the majority of control variables is available for a subset of sample years only, including them in the analysis reduces the sample size. Last, a distance-weighted average local business tax rate for the municipality's neighboring communities is added.[21] All variables show a considerable variation across communities. The associated descriptive statistics are reported in Table 1.

4 Empirical Methodology

In our empirical analysis, we estimate a model of the following form

$$t_{it} = \alpha_0 + \alpha_1 \log U_{it} + \alpha_2 \log L_{it} + \alpha_3 X_{it} + \epsilon_{it} \quad (14)$$

whereas t_{it} depicts the local business tax rate of community i at time t. U_{it} and L_{it} stand for the urbanization and localization measures defined in the previous section. Our theoretical model predicts that firm and industry agglomerations within a jurisdiction's borders exert a positive effect on the community's tax rate choice. Consequently, we presume $\alpha_1, \alpha_2 > 0$.

Moreover, we include a vector of control variables X_{it}. As indicated in the previous section, we account for first order differences in nature characteristics by including information on the soil quality and geographic landscape. This takes care of the fact that nature geographics may have historically determined the settlement of people and firms (and thus the emergence of economic agglomerations) but may simultaneously exert a direct effect on today's tax setting behaviour as governments have an incentive to tax rents related to characteristics of immobile land. Additionally, we include a set of control variables for public good provision and preferences (e.g. the number of railway stations, highway connections, the demographic composition) and the community's financial situation (e.g. the per capita deficit and per capita grants received) which may affect the community's tax rate choice. Furthermore, the distance-weighted average local business tax rate of neighboring communities is added to capture the responsiveness to the tax setting behavior of neighbors. To account for adjustment lags in the policy responses, all control variables enter as first lags. Moreover, we include

[21] The information on inhabitant net income, the communities' budget and demographic variables is retrieved from the German Federal Statistical office and its publication *Statistik Lokal*. Information on the infrastructure variables is obtained from the Bundesamt für Kartographie und Geodäsie.

a full set of year fixed effects to capture common shocks over time as well as a full set of fixed effects for 74 employment regions in West Germany defined according to German commuting patterns ("*Raumordnungsregionen*", see Bundesamt für Bauwesen und Raumordung).

The latter absorb differences between German commuting areas and imply that identification is achieved through cross-sectional variation within the employment regions. Note that adding jurisdictional fixed effects is not feasible in this framework as our agglomeration measures exhibit a shallow time variation only (confirming previous studies which suggest that geographic clusters are time-persistent, see e.g. Duranton and Overman (2005)). Instead of running cross-sectional regressions for every year, we choose the more efficient approach of pooling the observations and adjusting the standard errors such that they are robust to dependency in the error terms over time. This also yields unbiased estimates in the presence of unobservable municipality-specific random effects. The results presented in the following section moreover account for clustering at the level of the employment region and hence allow for common shocks to municipalities within the same employment area (whereas we derive comparable results if we cluster at the community level).

Furthermore, we correct the estimation described in equation (14) for a potential reverse causality bias. A large literature reports that corporate taxes exert a significantly negative effect on economic investment and firm location (for recent surveys, see de Mooij and Ederveen (2003) and Devereux (2007); for evidence on investment distortions of the German local business tax, see Becker, Egger, and Merlo (2008)). This suggests that OLS estimates are biased downwards and the true effect of agglomeration economies on the corporate tax rate choice is underestimated in OLS frameworks. To account for reverse causality, we employ an instrumental variable (IV) approach and construct a set of instruments Z_i for community i which are correlated with the agglomeration measures but are exogeneous to the error term ϵ_{it}. Formally, $Cov(U_i, Z_i) \neq 0$, $Cov(L_i, Z_i) \neq 0$ and $Cov(Z_i, \epsilon_i) = 0$. To test whether the instruments are correlated with the agglomeration measures, our first-stage estimation results will report the partial R-squared and F-test for the set of excluded instruments and a Stock-Yogo test for weak identification. Moreover, we are in the position to construct more instrumental variables than needed to identify the estimation system and thus, we employ a Sargan-Hansen overidentification test to determine whether the exogeneity assumption is fulfilled. The results are presented in Section 5.[22]

[22]Note that we consider our set of control variables to largely absorb systematic heterogeneity which may simultaneously drive agglomeration measures and the local business tax choice. However,

Our set of instrumental variables Z_i comprises long-lagged information on population and infrastructure measures. To ensure that the agglomeration measures are unaffected by the local business tax, we use information before the introduction of the first local business Tax Act ('Reichsgewerbesteuergesetz vom 1. Dezember 1936') in Germany in 1936. Our first set of instruments is constructed from a population census in 1910.[23] Although the population information is available for all communities in 1910, we have to address the problem that several jurisdictions have experienced adjustments in their jurisdictional borders since then. Precisely, in 1910 the area which is Germany today has hosted around 80,000 autonomous communities. Today the same area is divided into around 11,000 communities only. Using historical maps, we have linked the population data in 1910 to today's jurisdiction borders and thus constructed information on the long lagged population of today's municipalities.[24] The final matching rate to current West German municipalities amounts to 97 %. Note moreover that although long-lagged population data has been employed in other contexts to instrument for agglomeration economies (see e.g. Ciccone and Hall (1996) and Combes, Duranton, Gobillon, and Roux (2007)), our data is in many respects superior to these studies since we obtain long-lagged information for the whole territory of the German state in 1910 and do not have to restrict our analysis to jurisdictions (commonly cities) above a size threshold like earlier work.

Based on this long-lagged population information, we construct several instruments for our agglomeration measures. First, we include the long-lagged population size and population density respectively since agglomerations are perceived to be persistent over time and long-lagged size information is thus expected to be a strong determinant of today's agglomeration patterns. However, the access to consumer markets and the relative size compared to neighboring jurisdictions may have equally affected agglomeration dynamics in the last century and thus, we also construct the long-lagged market potential of the community (defined as the sum of inhabitants in neighboring communities normalized on geographic distance, analogously to the market potential definition in previous studies, see e.g. Charlot and Paty (2007)) and a long-lagged

as reverse causality and unobserved heterogeneity problems result in the same source of estimation bias (a correlation between the explanatory variables and the error term), our instrumental variable approach may also be considered to take care of remaining unobserved heterogeneity.

[23]Kaiserliches Statistisches Amt (1915), Die Volkszählung im Deutschen Reiche am 1. Dezember 1910, Kaiserliches Statistisches Amt, Berlin.

[24]Fortunately, names of historic municipalities did merely change over time and they could be precisely located as the data set was partitioned into single provinces which simplified the matching.

relative population size measure which is defined analogously to $U^r_{i,t}$.

Moreover, as a second set of instruments we include long-lagged information on the number of train connections which run through a considered municipality. The data is obtained from *Handbuch der deutschen Eisenbahnstrecken* and includes information on all train connections in Germany between the 1835 and 1935.[25] We match the long-lagged information on the railway system to the communities in our data set based on historic maps. Although past infrastructure investments are themselves driven by determinants at the time of construction (like e.g. population density and natural resources), they are equally perceived to impact on location decisions and agglomeration dynamics after their construction.[26] The long-lagged information on the German railway system may thereby serve as a particularly good instrument for the localization of industries since in Germany particularly manufacturing firms with comparably large transport costs tend to be localized for which the connection to the railway system may be of particular interest. From this long-lagged railway information, we define two instruments: first, the number of train connections which ran through a municipality between 1835 and 1935 and the train network in neighboring communities between 1835 and 1935 (the latter being defined as the sum of train connections which ran through neighboring communities normalized on distance).[27]

[25]Handbuch der deutschen Eisenbahnstrecken (1984): Eröffnungsdaten 1835-1935, Streckenlängen, Konzessionen, Eigentumsverhältnisse, Dumjahn, Mainz.

[26]This is, for example, also accounted for in a related framework by Redding, Sturm, and Wolf (2007) who show that the division of Germany into two states after World War II triggered a relocation of the airport hub from Berlin to Frankfurt (Main) which did not relocate back to Berlin after the reunification of Germany in 1990. This suggests that past infra-structure investments may prevail and may equally determine today's location patterns.

[27]Analogously to the definition of our agglomeration measures, we consider all other municipalities in Germany to be *neighbors* to a considered community whereas the distance normalization ensures that geographically close neighbors receive larger weights in the calculation. Note moreover that we only obtain information on train connections which were *opened* before 1935. The closure of train connections between 1835 and 1935 is not accounted for. Nevertheless, we expect the instrument to capture the infrastructure connection of a community during the considered time period. In cases in which train connections were abolished before 1935, additional noise is introduced which lowers the relevance of the instrument.

5 Results

Our results are depicted in Tables 4A-6. All regressions control for a full set of year fixed effects and a full set of fixed effects for German employment regions. Heteroscedasticity robust standard errors allowing for clustering at the level of the employment regions are presented in parentheses.

5.1 Effect of Own Agglomeration Characteristics

In Specifications (1)-(5) of Table 4A, we regress the municipalities' local business tax rate on an urbanization measure comprising the jurisdiction's number of employees (log $U^o_{i,t}$) and a localization measure comprising the number of employees in localized industries (log $L^{o1}_{i,t}$).[28] Controlling for a full set of commuting area fixed effects and year fixed effects, the coefficient estimates in Specification (1) suggest that both urbanization and localization economies exert a positive and statistically significant effect on the local business tax choice. Quantitatively, the regressions indicate that doubling the overall number of employees in the community raises the local business tax by 0.131 percentage points while doubling the number of localized employees raises the local business tax by 0.056 points. Evaluated at the sample mean of 16.6%, this corresponds to rise of the local business tax by 0.8% and 0.3%.

- Table 4A about here -

In Column (2), we reestimate the baseline specification additionally controlling for geographical characteristics and soil quality. Precisely, we add indicators relating to the fertility, erosion and slope of the soil and the geographical proximity of the community to rivers, mountains, the sea and lakes which turns out to leave both the urbanization and the localization effects qualitatively and quantitatively unaffected. Following a set of previous studies (see e.g. Büttner (2003)), Specification (3) moreover includes the lagged distance-weighted average local business tax rate of neighboring communities into the analysis to account for tax competition behavior between the municipalities.

[28]The results for the $L^{o1}_{i,t}$ and $L^{o2}_{i,t}$ measures presented in this section account for localized industries if the considered community hosts at least 0.5% of the localized industry's employees. This accounts for the fact that a critical industry fraction is likely to be required for localization economies to arise. Choosing a lower minimum threshold share derives similar results although the coefficient estimates for the localization measure tend to be somewhat smaller.

While the neighboring tax rate enters positively as expected, the coefficient estimates for the urbanization and localization measures remain statistically significant and quantitatively unchanged.

- Table 4B about here -

Apart from that, a community's tax rate choice may also be determined by its financial situation and spending needs. To account for that, Specification (4) additionally controls for the community type (by adding dummy variables indicating rural communities, border communities and state capitals), for the lagged per capita income level of the community's inhabitants as well as for the lagged financial deficit and the lagged administration and investment grants received from the federal and state governments. The coefficient estimates for the agglomeration measures are quantitatively smaller than in the previous specifications but keep their statistical significance. Including control variables for the demographic structure (the lagged population share aged above 65, the lagged population share aged below 14 and the lagged unemployment rate) and the infrastructure (the high way access, number of railway stations, number of airports and number of seaports) in a community further dampens the effect of the urbanization and localization measure on the local business tax rate which remains statistically significant though.[29]

[29] In robustness checks, we moreover included control variables for the political sphere (precisely the party affiliation of the major and the largest party in the city/community council) which are unfortunately available for a subset of German states only and hence drastically reduce the sample size. The inclusion of these controls does not alter our qualitative or quantitative regression results. Note moreover, that the control variables exhibit the expected signs. The coefficient estimate for the average neighbor tax enters positively (although insignificant in some specifications). As expected, the community's tax rate choice moreover rises in its lagged deficit, reflecting a larger financing need. The sign of the coefficient estimates for the grant measures is a priori ambiguous since larger grants on the one hand may relax the community's financing need but widely-used matching grant schemes may on the other hand equally raise the community's fundings needs. Our results suggest that the latter effect tends to prevail. Moreover, in line with intuition, the estimates suggest that rural communities tend to set lower business tax rates (corresponding to lower funding needs) and a high infrastructure provision (coefficient estimates are not reported in the paper) equally enhances the local business tax choice. Additionally, we find that communities with a large fraction of the population being aged above 65 or being unemployed tend to charge a larger local business tax rate which can be explained by larger spending needs as German municipalities are in charge of providing a relevant fraction of social assistance. Last, the per capita income variable enters negatively, although insignificant, which may firstly, reflect that inhabitants with high income levels are less likely to rely on social assistance

However, we expect the size of the localization economies not only to depend on the number of firms in localized industries but also on the industries' localization intensity. Hence, we additionally run regressions which account for the industries' tendency to cluster in space as determined by the DO index and reestimate our baseline regressions with a localization measures L_{it}^{o1} that comprises strongly localized industries only (with a DO index above the mean of the index distribution). The findings confirm the positive effect of urbanization and localization rents on the local business tax choice whereas, in line with intuition, the localization effect increases in size compared to the baseline specifications (the results are not reported in the paper to save on space). Table 4A depicts specifications including the localization variable L_{it}^{o2} which multiplicatively links the number of employees in a localized industry and the localization intensity as measured by the DO index. The results are reported in Columns (6) to (8) and again confirm our previous qualitative findings, in the sense that both, the localization and the urbanization measure exert a positive and statistically significant impact on the jurisdiction's corporate tax rate choice. Larger adjusted R-squared values moreover indicate that the new localization variable explains more variation in the local business tax rate across communities than the localization variable in the baseline regressions. Quantitatively, the estimates suggest that doubling the number of total and localized employees in a community respectively, raises the local business tax rate by 0.069 and 0.308 percentage points. Evaluated at the mean local business tax rate of 16.6%, this corresponds to a rise of 0.4% and 1.9%.[30]

The regression analysis has so far relied on standard OLS methodology. As described in Section 4, OLS estimates are however biased in the presence of reverse causality. Since a comprehensive literature finds evidence for a negative and sizable corporate tax effect on asset investment and firm location (see e.g. Devereux (2007)), we expect our OLS results to be distorted downwards. Following our argumentation in Section 4, we consequently employ an IV approach using long-lagged information on the community's population and train connections as instruments for our agglomeration measures.

but may secondly, also be driven by that fact that the German communities are entitled to a fraction of the inhabitants lagged income tax payments which may correlate with today's income.

[30]The interpretation of the coefficient estimate for the localization measure remains the same as in the baseline specification. To see this, note that $L_{it}^{o2} = \sum_m DO_m \times EMP_{i,m,t}$ can be rewritten $L_{it}^{o2} = \sum_m EMP_{i,m,t} \cdot \sum_m DO_m \times \lambda_{i,m,t} = L_{it}^{o1} \cdot \sum_m DO_m \times \lambda_{i,m,t}$, with $\lambda_{i,m,t} = EMP_{i,m,t} / \sum_m EMP_{i,m,t}$ being the share of localized industry m's employment relative to all employees in localized industries within the community. Assuming $\sum_m DO_m \times \lambda_{i,m,t}$ to be unaffected by changes in the overall number of localized employees $\sum_m EMP_{i,m,t} = L_{it}^{o1}$, the first derivative of equation (14) with respect to L_{it}^{o1} is $\partial t_{it} / \partial L_{it}^{o1} = \alpha_2 \cdot \frac{1}{L_{it}^{o2}} \cdot \sum_m DO_m \times \lambda_{i,m,t} = \alpha_2 \cdot \frac{1}{L_{it}^{o1}}$.

Since the overall number of employees U^o_{it} and the number of employees in localized industries L^{o1}_{it} are highly correlated (see Table 3), finding relevant and separate instruments for both agglomeration measures is fraught with difficulty. Nevertheless, as the correlation is substantially smaller between the urbanization measure U^o_{it} and the more sophisticated agglomeration measure L^{o2}_{it}, the latter allows for a separate identification of the effects in the IV approach.

The results are presented in Specifications (9) to (11) of Table 4A. The specifications account for endogeneity of the localization and urbanization variable by instrumenting with long-lagged information on the community's population and railway connections. Following previous studies, we moreover account for potential endogeneity of the distance-weighted average tax rate of neighboring communities (see Hines and Rice (1994)).[31] The results confirm the positive effect of urbanization and localization economies on the corporate tax rate choice whereas the coefficient estimates are, as expected, larger than in the OLS regressions. The increase in the coefficient estimate is moreover less pronounced for the localization measure which is in line with intuition as firms in localized industries are expected to retrieve higher location rents than firms in non-localized sectors. They are hence expected to react less responsive to tax rate changes which dampens potential reverse causality problems in our framework. Specification (11) suggests that doubling the number of total and localized employees raises the local business tax rate by 0.197 and 0.564 percentage points respectively or (evaluated at the sample mean) by 1.2% and 3.4%.

Note moreover, that our instrument set is found to be relevant and valid. To assess the relevance of the instruments, Table 4B reports the first stage regression results. Columns (1) and (2) depict the first stage for the urbanization and localization measures U^o_{it} and L^{o2}_{it} in Specification (11) of Table 4A. As predicted, both the long-lagged population variables and the long-lagged railway information tend to exert a positive and significant effect on the agglomeration variables. The partial R-squared of the excluded instrument set and the F-tests for the exclusion restrictions suggest the instruments to be relevant. Moreover, the quantitative impact of the instruments differs between localization and urbanization measures. Specifically, while the long-lagged population density and the long-lagged market potential tend to exert a quantitatively strong impact on the urbanization measure, the localization variable is strongly determined by the long-lagged railway connections, both in the considered and in neighboring communities, and by the relative long lagged population size compared to neighboring

[31] Following Hines and Rice (1994), we moreover add the distance-weighted average population size of the neighbors as an additional instrument to our IV set.

jurisdictions. This suggests that we do not face a weak instrument problem which is confirmed by the Stock-Yogo test reported in Table 4A.

Moreover, for the instrumental variables approach to be valid, the instruments must be exogeneous to the error term. The long-lagged nature of our IVs strongly suggests exogeneity whereas it has to be ensured that the instruments do not impact on the jurisdictional tax rate choice through any other channel than the agglomeration measures. Precisely, one may think about differences in nature characteristics which may in principle drive both long-lagged agglomeration characteristics and today's local business tax choice. However, as all specifications control for a large set of nature geographics, we consider this to be very unlikely. The exogeneity of the instrument set is confirmed in all instrumental variable specifications by a Sargan-Hansen overidentification test reported in Table 4A.

5.2 Effect of Relative Agglomeration Characteristics

Additionally, we follow our theoretical model and assess whether a municipality's tax setting behavior is affected by its relative agglomeration characteristics compared to neighboring jurisdictions. Hence, we regress the local business tax on the jurisdiction's relative urbanization compared to neighboring jurisdictions (log $U^r_{i,t}$) and its relative localization compared to neighboring jurisdictions (log $L^r_{i,t}$).

The results are presented in Table 5A. Specifications (1) to (3) employ a relative localization variable which accounts for all localized industries. The results suggest that both, the relative urbanization and localization measure, exert a positive and significant impact on the local business tax choice which turns out to be robust against the inclusion of the set of control variables described in the previous section. Interestingly, the relative agglomeration measures explain a larger fraction of the local business tax variation than the own agglomeration characteristics as indicated by the adjusted R-squared statistics (0.6407 in Column (5) of Table 4A versus 0.6531 in Column (3)).

- Table 5A about here -

Similar results are found if we reestimate the regressions employing the relative localization measure which accounts for strongly localized industries (with a DO-index above the mean) only in Specifications (4) to (6). In line with intuition, the coefficient estimates for the localization variable and the adjusted R-squared statistic increase in the latter specifications (as larger localization intensities are presumed to be associated with higher agglomeration rents). Moreover, running a specification with both, the community's own and relative agglomeration characteristics (as measured by the variables log $U^o_{i,t}$/log $L^{o2}_{i,t}$ and log $U^r_{i,t}$/log $L^r_{i,t}$ respectively) underpins the importance of the relative measures in explaining the jurisdictional tax rate choice. Precisely, in Specification (7), the coefficient estimates for the own agglomeration characteristics become insignificant while the coefficient estimates for the relative agglomeration characteristics remain qualitatively and quantitatively unaltered.

Moreover, we again account for a potential reverse causality bias as the relative agglomeration measures may be determined by tax policy choices (although less so than the own agglomeration measures in the baseline analysis). Thus, we reestimate Specifications (5) and (6) in an IV framework. The results are reported in Specifications (8) and (9) and confirm the positive impact of urbanization and localization on the tax rate choice. The first stage regressions in Table 5B and the Stock-Yogo test suggest our instruments to be relevant and the Sargan/Hansen overidentification test does not reject the null hypothesis that the IV set is exogeneous to the error term. Moreover, in line with our reverse causality presumption, both quantitative agglomeration effects are found to increase in the IV specifications.

- Table 5B about here -

Note that one advantage of using the relative agglomeration measures is that they absorb potential correlations of the degree of urbanization with a community's public good preferences or public good provision costs which may equally affect the local business tax choice.[32] While we account for these heterogeneity dimensions by including a large set of control variables in our baseline specifications, this problem is absent by construction for the relative agglomeration variables. To see this, consider the example of the agglomerations of Frankfurt(Main) and Dusseldorf. Both cities are large which may affect their fiscal needs. However, while Frankfurt is the only large metropolitan city in central Germany, Dusseldorf is surrounded by a set of other large cities in the Ruhr area. Thus, Frankfurt, in contrast to Dusseldorf, tends to be large in relative

[32]The sign of this correlation is unclear though. On the one hand, public spending preferences, for example for cultural goods, may increase in community size and enhance the fiscal need which might exert a positive effect on the local business tax. On the other hand, the population size of a community may imply economies of scale in providing public goods which tends to dampen the fiscal need and henceforth the local business tax.

terms. Put differently, Frankfurt belongs to the treatment group of the analysis while Dusseldorf is part of the control group. Precisely, both, the urbanization and the localization index, are about twice as large as for the city of Frankfurt than for the city of Dusseldorf and hence, Specification (9) suggests Frankfurt to set a by 0.32 percentage points larger local business tax rate for relative urbanization reasons and a by around 0.38 percentage points larger local business tax for relative localization reasons.[33]

Concluding, our analysis thus suggests that both urbanization and localization economies exert a positive impact on the local business tax and that especially communities with large agglomeration characteristics relative to their neighboring municipalities tend to choose large business tax rates.

5.3 Robustness Checks and Discussion

In robustness checks, we also experimented with alternative agglomeration measures to the ones reported in the previous section. We for example constructed a localization variable which additionally accounts for the share of the localized industry that is hosted by the considered community as a larger industry fraction may be expected to increase the localization rents retrieved by corporations. Precisely, we define $L_{it}^{o3} = \sum_{m=1}^{M} EMP_{i,m,t} \cdot DO_m \cdot s_{i,m,t}$ with $s_{i,m,t} = EMP_{i,m,t} / \sum_i EMP_{m,i,t}$ depicting community i's employment share of the localized industry m at time t. The measure again presupposes a complementary relationship between $EMP_{i,m,t}$, DO_m and $s_{i,m,t}$. Consequently, increases in the number of localized employees are assumed to exert a stronger impact on the tax rate, the larger the industry share hosted by the municipality and the larger the localization intensity of the industry. The results are presented in Specifications (1) and (2) of Table 6. Column (1) depicts a OLS specification with a full set of control variables. While the coefficient estimates confirm the positive effect of both, urbanization and localization economies, on the local tax rate choice, the quantitative effect of the localization measure and the adjusted R-squared turn out to be lower than in our baseline regressions (with an adjusted R-squared of 0.6425 vs. 0.6448 in our baseline specifications (see Column (8) of Table 4A)) which suggests that the fit of the specifications is inferior to our baseline regressions. The IV regression in Column (2) confirms this finding.

In a second step, we moreover assess the sensitivity of the *relative* agglomeration effect to alternative variable definitions. Precisely, we construct a relative localization

[33] The actual difference in the local business tax rates set by Frankfurt(Main) and Dusseldorf is around 1.6 percentage points.

measure for communities that host clusters of localized industries. For these localization centers, the measure captures the average geographical distance to other clusters in the same localized industry. We presume that the larger the average distance to other centers, the smaller the competitive pressure on the community and the larger its ability to tax the accruing localization rents. Formally, we define the measure $L^{r2}_{i,t} = \sum_{m=1}^{M} \sum_{j=1}^{J} \frac{DIST_{i,j}}{J}$ if $s_{i,m,t}, s_{j,m,t} > \alpha$, with $i \neq j$. $DIST_{i,j}$ depicts the distance between the considered community i and the neighboring jurisdiction j if both municipalities host a minimum employment share $s_{i,m,t}$,$s_{j,m,t} > \alpha$ in the localized industry m at time t. The index construction assumes $\alpha = 0.5\%$ and accounts for strongly localized industries (with a DO index above the mean) only whereas neither assumption is decisive for our qualitative findings. The results are reported in Columns (3) and (4) and indicate that the community's tax rate choice indeed increases in the distance to other localized industry centers. This confirms the notion that the relative localization compared to geographical neighbors exerts a positive impact on the local business tax choice.[34]

- Table 6 about here -

Additionally, our analysis has so far largely focused on agglomeration effects which arise due to *firm* clustering in space. Nevertheless, in the presence of trade costs, the corporate location decision is also expected to be affected by the distance to consumer markets. Thus, we run robustness checks on all our specifications, including a variable for a community's market potential. Following previous studies (see e.g. Charlot and Paty (2007)), we thereby define market potential as the market access to neighboring municipalities (formally, the total net household income in a neighboring jurisdiction normalized on distance, summed up over all German municipalities[35]). We find our results to be largely unaffected by this modification. Specifications (5) and (6) of Table 6 present the reestimation of the regressions in Columns (8) and (11) in Table 4A. The specifications show that including the market potential as a control variable leaves our agglomeration results qualitatively and quantitatively unaltered. Note moreover that the coefficient estimate for the market potential variable does not gain statistical significance. Although this runs counter to our expectation, the finding is in line with

[34]Reverse causality is not considered to play a relevant role with respect to the distance to other industry centers. Nevertheless, IV regressions for the latter localization measure show similar results (not reported in the paper).

[35]Following our previous argumentation, we again take the logarithm of the market potential measure to avoid results driven by outliers in the distribution.

previous results in the literature which e.g. report ambiguous effects of market access on direct investments (see e.g. Blonigen, Davies, Waddell, and Naughton (2007)).

Furthermore, it has been stressed in the literature that firms may benefit from locating in a community with a diverse industry structure as the diversity of economic environments may favor the productivity of firms through the cross-fertilization of ideas as described in Jacobs (1969). Hence, we additionally assess the robustness of our results to the inclusion of a measure for the community's industry diversification. A common variable used in the literature is the inverse Hirschman-Herfindahl index (see also Duranton and Puga (2000)). It is defined as the inverse of a municipality's sum of squared industry employment shares. A higher index indicates a more diversified municipality which holds employment shares across many different industries. The results are reported in Specifications (7) and (8) of Table 6. The OLS estimate in Specification (7) shows that diversification in the industry structure, as expected, exerts a positive impact on a jurisdiction's tax rate choice and leaves the coefficient estimates for our agglomeration measures largely unaffected. Instrumenting for the diversity index and the firm agglomeration measures in Specification (8) renders our IV approach invalid though as the Stock Yogo test indicates weak identification. This is in line with intuition since municipalities which comprise urbanization advantages in general also tend to host a large variety of different industries and the urbanization and diversification measures are thus highly correlated.

Moreover, our analysis so far accounted for localization variables which were constructed based on the DO methodology. As described in Appendix A and a companion paper (Koh and Riedel (2009)), we consider the DO approach to be superior to other approaches for the identification of industry localization patterns, including a widely-used methodology developed by Ellison and Glaeser (1997) (henceforth EG). Nevertheless, as a sensitivity check, we reconstructed our localization measures on the basis of the EG approach. In principle, the EG procedure identifies a comparable (although not identical) set of four-digit industries to be significantly localized. Methodology and findings are described in detail in Koh and Riedel (2009). Note that the EG approach also allows to derive an index for the localization intensity of an industry which we use for the construction of the agglomeration measures in an analogous way to the DO index in our main analysis. In general, using localization measures based on the EG approach confirms our previous findings (not reported in the paper). Nevertheless, the impact of the EG-measures on the local business tax choice is found to be quantitatively weaker which is in line with the EG index being a less precise measure for industry localization.

Last, several papers suggest that firms are more productive in economic and industry agglomerations. However, the source of this productivity advantage may principally root either in agglomeration economies or in the fact that more productive firms might select into urbanized areas. If the latter applies and firms face positive relocation costs, communities may exploit that firms are locked within their borders and set a positive tax rate which rises in the firm's productivity and hence, profitability. Nevertheless, previous empirical papers suggest that it is mostly agglomeration effects which drive the productivity advantage of firms in urbanized areas (see Combes, Duranton, Gobillon, Puga, and Roux (2009)) and thus, we are confident that the interpretation of our results as agglomeration effects is valid. Along the same lines, we check the underlying profitability determinants between the set of localized industries and non-localized industries in our study.[36] The literature suggest that it is mainly market concentration and specific investments which drive industry-productivity. Hence, as a robustness check we exclude those industries from the calculation of our localization measure which exhibit above average market power for a small number of firms (determined by a Herfindahl-Index) and are characterized by above average investments in research and development (R&D).[37] The results (not reported in the paper) indicate that the coefficient estimates remain largely unaffected by the modification in the definition of the localization variable which again suggests that interpreting the effects determined in this paper as agglomeration forces is valid.

6 Conclusion

This paper assesses whether policy makers take agglomeration rents into account when choosing their corporate tax rate. Employing unique data which merges local business tax rates set by German municipalities to information on agglomeration characteristics, we show that hosting firm clusters exerts a positive effect on the municipalities' tax setting behaviour. In doing so, we distinguish between general economic agglomera-

[36] If firms in localized industries are more profitable than firms in non-localized industries, the fact that jurisdictions choose to tax the former at a larger rate may be driven by positive relocation costs and the jurisdiction's incentive to tax larger rents at a higher rate. Note however that the literature has not brought forward an argument why more productive industries should have a larger incentive to exhibit agglomeration patterns.

[37] This modification, for example, implies that financial industries which belong to the group of localized sectors according to our DO approach, are dropped from the calculation of the localization measure.

tions (which give rise to urbanization economies) and industry clusters (which give rise to localization economies) and provide evidence that both tend to exert a positive and large effect on the local business tax choice. Our preferred estimates suggest that doubling the community's overall number of employees increases the local business tax by 1.2% on average while doubling the number of employees in localized sectors increases the local business tax rate by 3.4% on average.

Moreover, our analysis indicates that a jurisdiction's ability to tax away agglomeration rents depends on the *relative* size of its firm and industry agglomerations compared to neighboring communities. Thus, we find that it is those jurisdictions which host large economic agglomerations relative to neighboring jurisdictions that tend to choose high local business taxes. The same effect arises if jurisdictions host firm clusters in industries that are not (well) represented in municipalities closeby. In other words, it pays for jurisdictions to have an industry structure which is differentiated from their neighbors as the differentiation allows them to escape from corporate tax competition and to set a higher corporate tax rate.

Thus, our analysis confirms the prediction of the New Economic Geography literature which suggests that agglomeration rents are taxable to the community. Our paper however also offers a qualification of the argument in the sense that we tend to find agglomeration rents to be taxable only if the jurisdiction observes large agglomeration characteristics relative to neighboring communities. If neighboring communities are close substitutes instead, the race-to-the-bottom in corporate tax rates is reintroduced despite the presence of agglomeration rents.

From a policy perspective, our paper contributes to explaining why corporate tax rates at the local level remained relatively stable over the last decades despite an increasing interregional capital mobility. Moreover, the findings have implications for the design of regional economic policies that foster the development of new industry clusters. If one aim of regional policy is, for example, to strengthen the municipalities' revenue potential, our analysis suggests that the policy measures should allow for a differentiation in the economic and industry structure of neighboring communities in order to ensure that they are in the position to tax accruing agglomeration rents.

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Appendix A: Identifying Agglomerated Industries

The literature has proposed various approaches to identify the geographical location pattern of an industry. The most widely used methodologies have been developed by Ellison and Glaeser (1997) (henceforth EG) and Duranton and Overman (2005) (henceforth DO). Both approaches measure industry agglomeration over and above the overall concentration of economic activity and control for industrial concentration driven by firm-specific characteristics such as the plant size distribution. Nevertheless, as the EG index is prone to a set of shortcomings (see Koh and Riedel (2009) for a detailed discussion), we use the DO approach in the main analysis to identify localized four-digit industries. Robustness checks using the EG index are discussed in Section 5.

In the following, we briefly outline the DO-methodology, for a detailed description of the approach see Duranton and Overman (2005) and Koh and Riedel (2009). The basic intuition for the DO index is to estimate the density of bilateral distances between firms of the same industry and to compare the distribution of bilateral distances to the distribution of a hypothetical industry's randomly generated location pattern which has the same number of firms as the actual industry. An industry is considered as being localized at distance d if its distribution of bilateral distances departs significantly from randomness. In the first step, we calculate the bilateral distances of firms within each industry m using Gauss-Krüger coordinates available for each municipality. Defining $d_{i,j}$ as the distance between firm i and j of industry m, we estimate the density of distances $\hat{K}_m(d)$ at any distance d with

$$\hat{K}_m(d) = \frac{1}{n(n-1)h} \sum_{i=1}^{n-1} \sum_{j=i+1}^{n} f\left(\frac{d - d_{i,j}}{h}\right) \tag{A.1}$$

where n is the number of firms in industry m, f is the Gaussian kernel function with bandwidth (smoothing parameter) h. Next, we calculate counterfactual kernel density estimates for this industry by randomly drawing locations from the population of German firms. Repeating this simulation exercise 1000 times, we then compare the industry's actual location pattern to the simulated patterns and thus determine whether it significantly departs from randomness. To test the significance of the result, we construct local confidence bands which allow us to make statements about whether the location pattern of an industry deviates significantly from randomness at a certain distance. For our analysis, it is decisive whether firms are significantly localized within communities, which corresponds to significant localization at a distance of 0 kilometers with our approach (as our data does not allow us to identify the precise firm location within a community, the distance between firms located in the same community is set to 0, see Koh and Riedel (2009)). We hence follow DO and rank the simulated kernel density estimates $\tilde{K}_m$ at the distance of 0 kilometers in ascending order and select the 5th and 95th percentile. This yields a $\overline{\tilde{K}_m}$ which represents an upper 5% bound and a $\underline{\tilde{K}_m}$ which represents the lower 5% bound. An industry m is said to be localized at distance 0 if $\hat{K}_m > \overline{\tilde{K}_m}$ and the index of localization is defined as

$$DO_m \equiv max(\hat{K}_m - \overline{\tilde{K}_m}, 0). \tag{A.2}$$

The size of the index indicates how much localization occurs at a certain distance. It will serve as a proxy for the intensity of an industry's agglomeration in our analysis.

Appendix B: Tables

Table 1: Descriptive Statistics					
Variables:	*Observations*	*Mean*	*Std. Dev.*	*Min*	*Max*
Local Business Tax Rate	60,646	16.571	1.600	0	25
Own Agglomeration Measures					
Employees ($U^o_{i,t}$)	60,646	2,950.445	18,818.81	1	774,869
Log Employees (log $U^o_{i,t}$)	60,646	5.900	2.040	0	13.560
Localized Employees ($L^{o1}_{i,t}$)	60,646	576.649	6,656.624	0	305,731
Log Localized Employees (log $L^{o1}_{i,t}$)	60,646	1.527	2.711	0	12.630
Log (Localized Employees × DO) (log $L^{o2}_{i,t}$)	60,646	.133	.468	0	6.456
Relative Agglomeration Measures					
Log Relative Employees* (log $U^r_{i,t}$)	60,646	11.595	.873	-1.325	17.671
Log Relative Localized Employees* (log $L^r_{i,t}$)	37,551	8.907	.688	-.794	15.678
Control Variables					
Log Income per Capita, Lag	53,972	9.732	.100	9.460	10.238
Dist.Weighted Avg. Neighbor Tax Rate, Lag	53,980	13.753	.942	11.984	15.565
Administration Grants pC$^\blacktriangle$, Lag	28,989	198.391	128.461	-67.357	5,197.538
Investment Grants pC$^\blacktriangle$, Lag	28,989	73.991	159.290	-201.363	9,110.726
Deficit pC$^\blacktriangle$, Lag	28,989	19.829	3,691.076	-574,608	195,236.1
Highway Access	60,646	.151	.592	0	21
Number of Railway Stations	60,646	.553	.955	0	16
Number of Airports	60,646	.050	.227	0	2
Number of Seaports	60,646	.023	.184	0	7
Rural Community	60,646	.810	.392	0	1
Border Community	60,646	.022	.171	0	1
State Capital	60,646	.001	.038	0	1
Population Share Aged > 65, Lag	33,769	.174	.041	0	.423
Population Share Aged < 14, Lag	33,769	.166	.033	0	.317
Unemployment Rate$^\blacksquare$, Lag	33,614	.034	.013	0	.485
Instrumental Variables					
Population 1910	58,764	4,566.351	28,294.310	11	1,345,142
Log Population 1910	58,764	7.285	1.212	2.398	14.112
Log Population Density 1910	58,710	4.229	.773	-.846	8.007
Log Market Potential 1910*	58,764	12.116	.228	11.438	12.996
Log Rel. Population Share 1910*	58,764	.001	.035	-.007	1.6142
Train Connections 1935	56,841	.413	1.922	0	77
Log Train Connections 1935	56,841	.169	.449	0	4.358
Log Train Connections Neighbors 1935*	56,841	2.863	.275	2.122	3.882

Notes: $^\blacktriangle$ in Euros; * normalized on distance; $^\blacksquare$ The unemployment rate is calculated as the number of unemployed over the community's number of inhabitants. *(Log) Employees* stands for the (logarithm of the) number of employees in a municipality, *(Log) Localized Employees* for the (logarithm of the) number of employees in localized industries, as determined based on Duranton and Overman (2005), *(Log) (Localized Employees × DO)* is the logarithm of an index constructed as the number of employees in a localized industry times the DO index which accounts for the intensity of the industry's localization pattern, summed up over all localized industries located in a community. *Log Relative Employees* is the logarithm of an index capturing the community's number of employees compared to neighboring communities, normalized on distance (plus a constant which ensures that the index takes on positive values before taking the logarithm). *Log Relative Localized Employees* is the logarithm of an index capturing the community's number of employees in a certain localized industry compared to neighboring communities, normalized on distance and summed up over all localized industries (plus a constant which ensures that the index takes on positive values before taking the logarithm). In brackets behind the agglomeration measures, we include the variable names referring to the construction of the variables in Section 3.2. *Log Income per Capita, Lag* is the first lag of the average net income of a community's inhabitants, *Dist.Weighted Avg. Neighbor Tax Rate, Lag* is the first lag of the distance-weighted average local business tax rate in neighboring communities, *Administration Grants pC, Lag* is the first lag of the administration grants received by the community per capita, *Investment Grants pC, Lag* is the first lag of the investment grants received by the community per capita, *Deficit pC, Lag* is the first lag of the community's deficit per capita, *Highway Access* is the number of accesses to the highway network in the community, *Number of Railway Stations* is the number of railway stations in the community, *Number of Airports* is the number of airports in the community, *Number of Seaports* is the number of seaports in a community, *Rural Community* is a dummy variable indicating rural communities with less than 7500 inhabitants, *Border Community* indicates communities located at the national border, *State Capital* indicates communities which are the capital of a German state, *Population Share Aged > 65, Lag* is the first lag of the share of the community population which is aged 65 or older, *Population Share Aged < 14, Lag* is the first lag of the fraction of the community population which is aged 14 or younger, *Unemployment Rate, Lag* is the first lag of the unemployment rate, *(Log) Population 1910* is (the logarithm of) the community's long-lagged number of inhabitants in 1910, *(Log) Population Density 1910* is (the logarithm of) the community's long-lagged population density in 1910, *(Log) Market Potential 1910* is (the logarithm of) the market access of a community in 1910 as captured by the sum of the population in neighboring communities normalized on distance, *(Log) Relative Population Share 1910* is (the logarithm of) an index capturing a community's relative population share compared to neighboring municipalities, normalized on distance. *(Log) Train Connections 1935* is (the logarithm of) the number of train connections which run through a community in 1935, *(Log) Train Connections Neighbors 1935* is (the logarithm of) the number of train connections which run through neighboring communities in 1935, normalized on distance. A detailed description of the variable construction can be found in the main text.

Table 2: Localized Four-digit Industries with DO>Mean	
Four-digit Code*	**Name of Industry**
1520	Processing and preserving of fish, crustaceans and mollusca
1594	Manufacture of cider and other fruit wines
1715	Preparation and spinning of textile fibres
1721-24	Weaving of cotton and carded and silk yarn
1760	Manufacture of knitted and crocheted fabrics
2211	Publishing of sound recordings and books
2213	Publishing of magazines
2461	Manufacture of explosives
2613	Manufacture of hollow glass
2731-34	Cold drawing of bars, wire and cold rolling of narrow strip
2752	Casting of steel
2840	Forging, pressing, stamping and roll-forming of metal; powder metallurgy
2861-62	Manufacture of cutlery and tools
2874	Manufacture of fasteners and screw machine products
3350	Manufacture of watches and clocks
3511	Building of ships and floating structures
3622,3661	Jewelery and related articles
4532	Other construction installation
6022	Urban passenger land, sea and coastal water and air transport
6323	Service activities incidental to water and air transportation
6523,6602	Other financial intermediation and pension funding
6711-12	Administration of financial markets; security and commodity contracts brokerage
7020	Renting and operating of own or leased real estate
7031-32	Management of real estate on a fee or contract basis
7320	Research and experimental development on social sciences and humanities
7413-14	Market research and public opinion polling, consultancy activities
7440	Advertising
9211-12	Motion picture, video and television programme activities
9232	Operation of arts facilities
9240	News agency activities

* The 4-digit industry classification follows the German code "Klassifikation der Wirtschaftszweige WZ(93)".

Table 3: Correlation between Local Business Tax and Agglomeration Measures

	Tax Rate	Log Empl. ($\log U_{it}^{o}$)	Log Loc. Empl. ($\log L_{it}^{o1}$)	Log (Loc. Empl. × DO) ($\log L_{it}^{o2}$)	Log. Rel. Empl. ($\log U_{it}^{r}$)
Log Employees ($\log U_{it}^{o}$)	0.364				
Log Localized Employees ($\log L_{it}^{o1}$)	0.358	0.671			
Log (Localized Employees × DO) ($\log L_{it}^{o2}$)	0.364	0.498	0.663		
Log Relative Employees ($\log U_{i,t}^{r}$)	0.343	0.775	0.715	0.677	
Log Relative Localized Employees ($\log L_{i,t}^{r}$)	0.376	0.555	0.580	0.831	0.714

Notes:

(Log) Employees stands for the (logarithm of the) number of employees in a municipality, *(Log) Localized Employees* for the (logarithm of the) number of employees in localized industries, as determined based on Duranton and Overman (2005), *(Log) (Localized Employees × DO)* is the logarithm of an index constructed as the number of employees in a localized industry times the DO index for the intensity of the industry's localization pattern, summed up over all localized industries located in a community. *Log Relative Employees* is the logarithm of an index capturing the community's number of employees compared to neighboring communitites, normalized on distance. *Log Relative Localized Employees* is the logarithm of an index capturing the community's number of employees in a certain localized industry compared to neighboring communitites, normalized on distance and summed up over all localized industries. In brackets, we include the variable names referring to the construction of the agglomeration measures in Section 3.2.

Table 4A: Own Agglomeration Characteristics I, DO - Intra-Community Industry Cluster

Dep. Variable: Local Business Tax Rate, Localization Measure: Number of Employees (in Localized Industries)

Expl.Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Localization Measure	.056***	.056***	.055***	.031***	.018**	.577***	.402***	.308***	.756***	.528***	.564***
	(.010)	(.010)	(.010)	(.008)	(.018)	(.070)	(.069)	(.065)	(.147)	(.163)	(.161)
Urbanization Measure (log U^o_{it})	.131***	.125***	.126***	.104***	.079***	.106***	.086***	.069***	.145***	.191***	.197**
	(.021)	(.020)	(.020)	(.022)	(.022)	(.018)	(.019)	(.020)	(.039)	(.066)	(.083)
Avg. Tax Neighbor, Lag			.387***	.300	.240	.385***	.295	.235	.513	.743*	.714*
			(.091)	(.232)	(.238)	(.092)	(.231)	(.237)	(.442)	(.390)	(.412)
Log Income per Capita, Lag				-.419	-.183		-.295	-.144		-.612	-.625
				(.594)	(.634)		(.610)	(.652)		(.646)	(.692)
Deficit/10^3, Lag				.451***	1.120***		.436***	1.110***		.679***	1.150***
				(1.110)	(.117)		(.101)	(.112)		(.065)	(.096)
Administration Grants/10^3, Lag				1.427***	1.250***		1.272***	1.182***		1.480***	1.551***
				(.231)	(.225)		(.202)	(.211)		(.302)	(.400)
Investment Grants/10^3, Lag				-.145	-.077		-.129	-.071		-.202	-.117
				(.101)	(.064)		(.090)	(.061)		(.126)	(.090)
Population Share > 65, Lag					1.248**			1.289**			.374
					(.531)			(.529)			(.788)
Population Share < 15, Lag					-1.761**			-1.604**			-1.691**
					(.752)			(.735)			(.843)
Unemployment Rate, Lag					7.245***			6.544***			-.064
					(2.163)			(2.179)			(3.399)
First Nature Geographics		√	√	√	√	√	√	√	√	√	√
Community Type				√	√		√	√		√	√
Infrastructure					√			√			√
Localization Measure Used (log)	L^{o1}_{it}	L^{o1}_{it}	L^{o1}_{it}	L^{o1}_{it}	L^{o1}_{it}	L^{o2}_{it}	L^{o2}_{it}	L^{o2}_{it}	L^{o2}_{it}	L^{o2}_{it}	L^{o2}_{it}
# Observations	60,646	60,646	53,980	28,989	28,204	53,980	28,989	28,204	48,857	21,065	20,373
# Communities	6,776	6,776	6,776	6,050	6,042	6,776	6,050	6,042	6,139	5,458	5,455
Adj. R-squared	0.5696	0.5766	0.5785	0.6300	0.6407	0.5929	0.6365	0.6448			
Stock Yogo									41.024	26.662	19.837
Sargan Hansen, p-value (dof)									0.3607(3)	0.9471(3)	0.8840(3)

<u>Notes:</u>

Heteroscedasticity robust standard errors adjusted for commuting area clusters in parentheses. *, **, *** indicate significance at the 10%, 5%, 1% level. The observational units are German municipalities per year, the dependent variable is the municipalities' local business tax rate. The urbanization measure is the logarithm of the number of employees (log U^o_{it}) in all specifications. The localization measure accounts for localized industries in Germany as identified on the basis of the DO approach. In Specifications (1) to (5), we employ the localization measure log L^{o1}_{it}, in Specifications (6) to (11) the localization measure log L^{o2}_{it} (see Section 3.2 for details). For a detailed description of the control variables, see Section 3.3 or the notes to Table 1. Additionally to the control variables depicted in the table, all regressions include a full set of year and commuting area fixed effects.

Table 5A: Effect of Relative Agglomeration Characteristic on Tax Rate Choice

Dep. Variable: Local Business Tax Rate, Agglomeration Measures: Relative Number of Employees (in Localized Industries)

Expl. Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Relative Localization	.092**	.100***	.073**	.279***	.203***	.183***	.192***	.375**	.379**
	(.042)	(.039)	(.036)	(.044)	(.040)	(.038)	(.046)	(.185)	(.167)
Relative Urbanization (log U^r_{it})	.419***	.336***	.282***	.372***	.329***	.256***	.249***	.329***	.322**
	(.059)	(.064)	(.071)	(.048)	(.059)	(.063)	(.083)	(.133)	(.135)
Own Localization (log L^{o2}_{it})							-.018		
							(.081)		
Own Urbanization (log U^o_{it})							.006		
							(.030)		
Log Income per Capita, Lag			-.065		-.166	-.153	-.166	-.182	-.285
			(.680)		(.697)	(.726)	(.725)	(.727)	(.758)
Avg. Tax Neighbor, Lag	.381***	.246	.202	.019***	.012	.010	.205	.532	.468
	(.101)	(.239)	(.250)	(.005)	(.012)	(.012)	(.251)	(.347)	(.363)
Deficit/10^3, Lag		.043***	.011***		.043***	.012***	.012***	.006***	.011***
		(.010)	(.001)		(.010)	(.001)	(.001)	(.001)	(.001)
Administration Grants/10^3, Lag		1.492***	1.343***		.001***	1.343***	1.353***	1.339***	1.323***
		(.220)	(.235)		(.000)	(.235)	(.249)	(.197)	(.223)
Investment Grants/10^3, Lag		-.045	-.051		-.000	-.051	-.051	-.095	-.092
		(.108)	(.104)		(.000)	(.104)	(.104)	(.142)	(.124)
Population Share > 65, Lag			1.188			.728	.709		.984
			(.810)			(1.059)	(1.047)		(1.080)
Population Share < 15, Lag			-1.630			-3.155**	-3.158**		-2.209
			(1.109)			(1.485)	(1.483)		(1.407)
Unemployment Rate, Lag			4.391*			4.845*	4.794*		-.602
			(2.550)			(2.5518)	(2.530)		(3.268)
First Nature Geographies	√	√	√	√	√	√	√	√	√
Community Type		√	√		√	√	√	√	√
Infrastructure			√			√	√		√
Localization Measure Used (log)	L^r_{it}	L^r_{it}	L^r_{it}	L^r_{it} DO>Mean	L^r_{it} DO>Mean	L^r_{it} DO>Mean	L^r_{it} DO>Mean	L^r_{it} DO>Mean	L^r_{it} DO>Mean
# Observations	48,582	26,393	25,853	33,043	20,797	20,780	20,780	15,007	14,999
# Commuting Areas	6,075	5,464	5,464	5,627	4,859	4,858	4,858	4,298	4,297
Adj. R-squared	0.6079	0.6474	0.6531	0.6352	0.6749	0.6796	0.6796		
Stock Yogo								22.864	22.381
Sargan Hansen, p-value (dof)								0.6672(4)	0.8217(4)

Notes:

Heteroscedasticity robust standard errors adjusted for commuting area clusters in parentheses. *, **, *** indicate significance at the 10%, 5%, 1% level. The observational units are German municipalities per year, the dependent variable is the municipalities' local business tax rate. The urbanization measure is the relative number of employees compared to neighboring communities (log U^r_{it}, see Section 3.2). The localization measure analogously captures the number of employees in a localized industry - according to DO - relative to neighboring communities (log L^r_{it}, see Section 3.2). For a detailed description of the control variables, see Section 3.3 or the notes to Table 1. Additionally to the control variables depicted in the table, all regressions include a full set of year and commuting area fixed effects.

Table 4B: First Stage to the Own Agglomeration Regressions		
	# Loc. Empl.∗DO (Localization, log L_{it}^{o2})	# All Employees (Urbanization, log U_{it}^{o})
	(1)	*(2)*
Log Population Density 1910	.028**	.507***
	(.013)	(.051)
Log Market Potential Pop 1910	.322**	1.207**
	(.156)	(.549)
Log Rel. Population 1910	10.385***	3.838*
	(1.141)	(2.038)
Log Train Connections 1935	.067***	.300***
	(.023)	(.038)
Log Train Connections Neigh. 1935	.132**	.124
	(.051)	(.188)
# Observations	20,373	20,373
F-test (p-value)	0.000	0.000
Partial R-Squared of Excl. IVs	0.2110	0.1078

Notes:

Table 4B depict the first stage regression to the specification shown in Column (11) of Table 4A. The dependent variable in the first (second) column is the localization measure log L_{it}^{o2} (the urbanization measure log U_{it}^{o}) as defined in Section 3.2.

Table 5B: First Stage to the Relative Agglomeration Regressions		
	# Rel. Loc. Employees (Localization, log L_{it}^{r})	# Rel. Employees (Urbanization, log U_{it}^{r})
	(1)	*(2)*
Log Population 1910	.085***	.369***
	(.015)	(.014)
Log Population Density 1910	.049***	-.021
	(.016)	(.016)
Log Market Potential 1910	.616***	.236*
	(.148)	(.126)
Log Rel. Population 1910	10.535***	5.032***
	(1.221)	(1.003)
Log Train Connections 1935	.087***	.114***
	(.027)	(.020)
Log Train Connections Neigh. 1935	.013***	.007**
	(.004)	(.003)
# Observations	14,999	14,999
F-test (p-value)	0.000	0.000
Partial R-Squared of Excl. IVs	0.1710	0.3124

Notes:

Table 5B depict the first stage regression to the specification shown in Column (9) of Table 5A. The dependent variable in the first (second) column is the relative localization measure log L_{it}^{r} (the urbanization measure log U_{it}^{r}) as defined in Section 3.2.

Table 6: Robustness Checks

Dep. Variable: Local Business Tax Rate

	Own Aggl.		**Rel. Aggl.**		**Market Potential and Diversity**			
Expl. Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Localization Measure	.123***	.452***	.355***	.155*	.280***	.564***	.304***	.556**
	(.035)	(.126)	(.077)	(.085)	(.062)	(.160)	(.063)	(.225)
Urbanization Measure (log U^o_{it})	.076***	.176**	.571***	.447***	.066***	.198***	.050**	.220
	(.021)	(.082)	(.058)	(.082)	(.020)	(.075)	(.020)	(.445)
Log Market Potential					.067	-.012		
					(.383)	(.508)		
Diversification							.069***	-.050
							(.023)	(1.016)
Log Income per Capita, Lag	-.130	-.508		-1.144	-.179	-.623	-.191	-.635
	(.639)	(.714)		(1.146)	(.669)	(.713)	(.653)	(.685)
Avg. Tax Neighbor, Lag	.232	.677	.361	.934**	.245	.710	.247	.709
	(.238)	(.422)	(.222)	(.429)	(.241)	(.484)	(.235)	(.456)
Deficit/10^3, Lag	.011***	.011***		.220***	.011***	.012***	.011***	.012***
	(.001)	(.001)		(.108)	(.001)	(.001)	(.001)	(.001)
Administration Grants/10^3, Lag	1.213***	1.556***		2.550***	1.181***	1.552***	1.135***	1.620
	(.218)	(.389)		(.459)	(.213)	(.375)	(.197)	(1.281)
Investment Grants/10^3, Lag	-.072	-.121		.138	-.068	-.117	-.051	-.133
	(.063)	(.090)		(.355)	(.060)	(.089)	(.060)	(.326)
Share Population > 65, Lag	1.266**	.491		-5.403**	1.332**	.369	1.327**	.298
	(.530)	(.800)		(2.717)	(.519)	(.739)	(.532)	(1.443)
Share Population < 14, Lag	-1.710**	-1.615*		-7.185*	-1.596**	-1.692**	-1.723**	-1.596
	(.749)	(.848)		(3.830)	(.737)	(.830)	(.738)	(2.328)
Unemployment Rate, Lag	6.879***	-.468		5.862	6.495***	-.083	6.190***	-.190
	(2.157)	(3.416)		(6.862)	(2.161)	(3.046)	(2.220)	(3.067)
First Nature Geographies	√	√	√	√	√	√	√	√
Community Type	√	√		√	√	√	√	√
Infrastructure Var.	√	√		√	√	√	√	√
Localization Measure Used (log)	L^{o3}_{it}	L^{o3}_{it}	L^{r2}_{it}	L^{r2}_{it}	L^{o2}_{it}	L^{o2}_{it}	L^{o2}_{it}	L^{o2}_{it}
# Observations	28,204	20,373	4,228	2,493	28,204	20,373	28,204	20,373
# Commuting Areas	6,042	5,455	685	618	6,042	5,455	6,042	5,455
Adj. R-squared	0.6425	–	0.6934	0.7875	0.6453	–	0.6460	–
Stock Yogo		13.425				18.256		1.279
Sargan Hansen, p-value (dof)		0.9403(3)				0.7270(2)		0.7249(2)

Notes:

Heteroscedasticity robust standard errors adjusted for commuting area clusters in parentheses. *, **, *** indicate significance at the 10%, 5%, 1% level. The observational units are German municipalities per year, the dependent variable is the municipalities' local business tax rate. The urbanization measure is the number of employees (log U^o_{it}). The localization measure in Columns (1) and (2) is log L^{o3}_{it}. In Specifications (3)-(4) the localization measure is the community's average distance to other municipalities which hold an industry center of the same localized industry, summed up over all localized industries (log L^{r2}_{it}). Specifications (5)-(8) reestimate Specifications (8) and (11) of Table 4A, additionally including control variables for the consumer market access and industry diversification. In Specifications (5)-(6), *Log Market Potential* is the logarithm of the sum of the overall net income of all neighboring communities, normalized on distance, and hence measures a location's market access (see Head and Mayer (2004)). In Specifications (7)-(8), *Diversification* denotes the inverse Hirschman-Herfindahl index and measures the degree of diversification within a municipality (see also Duranton and Puga (2000)). It is defined as the inverse of a municipality's sum of the squared industry employment shares, where a higher index therefore indicates a more diversified municipality. For a detailed description of the control variables, see Section 3.3 or the notes to Table 1. Additionally to the control variables depicted in the table, all regressions include a full set of year and commuting area fixed effects.

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