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Why the Current Tax Rate Tells You Little: Competing For Mobile and Immobile Firms*

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Preliminary - do not distribute

Abstract

This paper analyses if, and to which extent, firms anticipate future tax rate changes. The weight of future tax rates in firms' location decisions may explain differences in the sensitivity of firms' location decision to current tax rates. Firms with high relocation costs, for example, are more sensitive to expected future changes in the tax rate, as they find it more costly to react to tax rate increases later. Governments react to this behavior by increasing the corporate tax rate if the share of firms with high relocation costs is high. We first derive these effects in a simple model and then test for them empirically, using the evolution of a new and highly immobile industry (wind turbines) for identification.

Keywords: corporate taxation, firm mobility, commitment, tax competition

JEL Classification: H25, H71, F21

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1 Introduction

Corporate tax rates are an important determinant of firms' location decisions. A ten percentage point lower corporate tax rate increases foreign direct investment by 16% on average (Feld and Heckemeyer, 2011). However, it is not only the tax rate today, but also the expected future tax rates over the lifetime of the investment that matter for the investment decision. Consider, for example, a firm that decided in 2000 to invest in either the United States or Canada. In that year, both countries had a corporate tax rate of around 40%. Over the next ten years, Canada lowered its tax rate by more than ten percentage points, while the U.S. tax rate remained constant. A firm that foresaw these changes would have preferred to invest in Canada (assuming that it would have been indifferent between the two countries in the absence of taxes).

The academic literature has so far largely neglected such expectations about future tax rates. In this paper, we provide a first study that considers both theoretically and empirically whether firms anticipate future tax rate changes. We show that the relative importance of future tax rates in a firm's location decision depends on the firm's relocation mobility. Firms with high relocation costs, for instance, are more sensitive to expected future changes in the tax rate, as they find it more costly to react to tax rate increases later. Governments anticipate firm behavior and set their tax rates accordingly; that is, they increase the tax rate when the share of immobile firms in the tax base rises.

Our results have important implications for policymakers. We show that decreases in the corporate tax rate are unlikely to be effective in attracting investments if the government cannot credibly commit to keep the tax rate low. As its credibility is strongly influenced by the mobility of firms locating in the jurisdiction, the government may not be able to influence its credibility, at least in the short term. Furthermore, our results suggest that prior empirical studies analyzing the role of tax policy on firm' decisions or the welfare costs of corporate taxation may be biased, as they use the current tax rate to approximate firms' current and future tax burden.

In more detail, our paper starts by setting up a model in which governments compete for mobile and immobile firms (i.e. firms with very low and very high relocation costs). We show that governments face commitment problems as a higher share of immobile firms poses an incentive to increase the tax rate. A strategy to lower the tax rate to attract immobile firms is thus not always credible. Accordingly, immobile firms prefer to locate in jurisdictions with a large share of mobile firms, as the mobile firms

continue to pressure the government to keep tax rates low. Similarly, mobile firms are less likely to locate in (and more likely to relocate away from) a jurisdiction if the share of immobile firms in this jurisdiction is high.

We test our hypotheses empirically using the evolution of a new industry with very high relocation costs in Germany after 2000. Due to generous subsidies for green electricity, the number of wind turbines increased from roughly 5,000 in 2000 to over 23,000 in 2012. Since the most important factor in the location decision of wind turbines is wind strength, our setting allows us to explore exogenous variation in the local business tax base share of immobile firms in municipalities in Germany.

Based on panel data for 1998 to 2011 and using OLS and IV estimations in differences, we show that municipalities increase their tax rate on immobile and mobile firm profits by on average 7%, or 1.25%-points, if the tax base share of immobile firms increases from 0 to 50%. Furthermore, we estimate Poisson models on the municipality level to study the location decision of immobile firms between 2000 and 2011. Our results suggest that an increase in the share of immobile firms by 1 multiplies the negative effect of the tax rate on wind turbines' location decision by the factor 5. Thus, immobile firms anticipate governments' commitment problem.

Complementarily, we assess the relocation decision of mobile firms between 2006 and 2011 using the financial statements data base DAFNE, which covers more than 90% of all incorporated firms in Germany. Based on logit estimations, in which we control for firm and county specific effects as well as for a variety of firm level and municipality level variables, we find that the probability to relocate triples if the share of immobile firms increases from 0 to 1.

Finally, we show that our findings are not limited to this particular setting. To do so, we construct a general indicator of firm mobility on the municipality level based on the relocation decisions observed in DAFNE. Using variation in the relocation probability of firms on the 2 digit industry level, which is then averaged for all firms within a particular municipality, we show that an increase in firm mobility by 1%-point relates to a 10 to 15% decrease in the local business tax rate.

Our paper relates to at two lines of literature. First, it relates to the literature that considers the tax sensitivity of firms' location decisions. Taxes deter firms' from locating in a particular jurisdiction (Mooij and Ederveen, 2008; Feld and Heckemeyer, 2011). However, firms greatly differ in their tax rate sensitivity. For example, theoretical models have shown that agglomeration benefits reduce the tax rate sensitivity

of firms (Baldwin and Krugman, 2004; Borck and Pflüger, 2006). Using a sample of Swiss startups, Brühlhart et al. (2012) test these predictions empirically and find that agglomeration forces diminish firms' sensitivity to tax differentials. Agglomeration and urbanization rents are therefore a major determinant of corporate tax rates, as they can be taxed away by jurisdictions (e.g. Jofre-Monseny, 2013; Koh et al., 2013).

Second, we also contribute to the literature on the determinants of corporate tax rates. A major explanation of the overall downward movement of corporate tax rates worldwide is that states compete for increasingly mobile capital (this tax competition literature is surveyed by Zodrow, 2010). Within this literature, our paper is closest related to Haupt and Krieger (2013), who set up a two-period model in which governments first compete in subsidies to attract firms, and then compete in taxes to avoid firm relocation. They find that higher relocation mobility increases net tax revenue, as the resulting fall in subsidy competition overcompensates the intensified tax competition.

Lastly, our paper is related to the literature on commitment in fiscal policy going back to Kydland and Prescott (1977), who established that a rational and forward-looking government that chooses a time plan for policy to maximize welfare will later re-optimize and change its plan if it can.

This paper proceeds as follows. Section 2 provides a theoretical model of firms' location decisions and the government's tax rate choice. Section 3 introduces our identification strategy and provides some background information on the renewable energy sector in Germany. Section 4 analyses how municipalities react to a larger share of immobile firms, and Section 5 studies whether firms anticipate the municipalities' behavior. Section 6 shows that our results also hold in a more general setting. Section 7 concludes.

2 Model

2.1 Setup

We set up a dynamic model with an infinite number of periods $t = 1, 2, \dots$. The world in the model has many jurisdictions j , which offer different locational advantages for firms. Each jurisdiction sets a tax rate τ_{jt} , which it can adjust in every period t . In the benchmark model, jurisdictions set the tax rate to maximize current period

tax revenues. The jurisdictions compete with a tax haven, which offers no locational advantage for the firms but also does not tax profits.

Each firm in the model lives for two periods. There are two firm types: *Mobile* firms which can relocate in the second period, and *immobile* firms which cannot relocate. Mobile firms realize a profit of $\beta_j \pi^M$ in every period, where $\beta_j \geq 1$) is the locational advantage for mobile firms of jurisdiction j . In each period, a mass M of potential entrants obtains the option to enter the market in jurisdiction j at a fixed cost f_i . This fixed cost is firm-specific and follows a uniform distribution in $[0, 1]$. Firms have to enter in this specific jurisdiction, and each firm has to remain in this jurisdiction for one period. In the second period, the mobile firm may relocate to a tax haven with $\beta_{Haven} = 1$ at the same fixed cost f_i . After the second period, the firm ceases to exist.¹

Immobile firms realize a profit of $\alpha_j \pi^I$ in every period, where α_j is the locational advantage for immobile firms in location j . Immobile firms have a fixed set-up cost of c_i when they become active, with c_i uniformly distributed in $[0, 1]$. At any point in time, at most one immobile firm may be active in each jurisdiction.² If no immobile firm is currently active in a jurisdiction, there is one potential entrant which draws a realization of the fixed cost c_i and decides based on this fixed cost and its expected after-tax profit whether to enter or not. If the firm enters, it exists for two periods. These immobile firms cannot relocate, because they are bound to resources that exist only in this jurisdiction or the cost of relocation is prohibitively high. Examples could be mining companies, oil extractors, or wind turbines (which will be the focus of our empirical test).

In each period, the government first sets the tax rate. Then, firms decide about entry and relocation. At the end of the period, taxes are paid. For ease of notation, we drop the index j for the jurisdiction in the following.

2.2 Firm Entry and Relocation Decisions

Immobile Firms. If no immobile firm is currently active in a jurisdiction, an entrepreneur in this jurisdiction has the option to become active. He or she draws a fixed cost parameter c_i and, given this fixed cost, decides whether to enter based on

¹Thus, as in an “overlapping generations” model, always two generations of mobile firms are active. This framework is similar to the “vintage investment” model of Konrad and Kovenock (2009).

²This is a normalization that enables us to focus on the share of mobile vs. immobile firms later on and allows us to abstract from the size of the jurisdiction.

the firm's expected, discounted after-tax profits. The entrepreneur anticipates that the immobile firm's entry will affect the tax rate in the next period. The firm enters if

$$(1 - \tau_t) \alpha \pi^I + \delta (1 - \tau_{t+1, n^I=1}) \alpha \pi^I > c_i, \quad (1)$$

where δ is the discount factor and $(1 - \tau_{t+1, n^I=1})$ is the tax rate in the following period if the immobile firm has entered.

As the fixed cost of entry c_i follows a uniform distribution, the probability that an immobile firm enters in period t is given by

$$n_t^I = \alpha \pi^I (2 - \tau_t - \delta \tau_{t+1, n^I=1}). \quad (2)$$

Mobile Firms. A potential mass of mobile firms M may enter jurisdiction j in period t . Only those firms with sufficiently low fixed costs will enter. In their entry decision, the mobile firms anticipate that the tax rate may change in the next period because an immobile firm could enter. While the mobile firms do not know in advance whether an immobile firm will enter, they observe the jurisdiction's locational advantage for immobile firms and can thus form an expectation about the entry probability of immobile firms. Mobile firms enter if their fixed cost are sufficiently small, i.e. if given by

$$f_i < (1 - \tau_t) \beta \pi^M + \delta (1 - \overline{\tau_{t+1}}) \beta \pi^M = f^*. \quad (3)$$

$\overline{\tau_{t+1}}$ denotes the expected tax rate in $t+1$, anticipating that the government will adjust the tax rate if an immobile firm enters.

Mobile firms can relocate in the second period of their activity. As relocation requires a second payment of the fixed cost f_i , only those firms with relatively low fixed costs will relocate. Assuming that not all firms relocate in the second period, the option to relocate is not relevant for the marginal firm that determines f^* , as this firm has relatively high fixed costs. Thus, relocation does not have to be taken into account in eq. (3).

In period t , the mobile firms that have entered in $t-1$ can relocate to a tax haven. The tax haven offers a tax rate of $\tau_{Haven} = 0$, but has no locational advantage ($\beta_{Haven} = 1$). The firm decides to relocate if

$$(1 - \tau_t) \beta \pi^M < \pi^M - f_i. \quad (4)$$

Using that f_i is uniformly distributed in $[0, 1]$, the mass of mobile firms that are active

in period t is

$$M_t^M = [(1 - \tau_t) \pi^M + \delta (1 - \overline{\tau}_{t+1})] \beta M + [(1 - \tau_{t-1}) \pi^M + \delta (1 - \overline{\tau}_t)] \beta M - [1 - (1 - \tau_t) \pi^M] \beta M. \quad (5)$$

The first line represents the firms that enter in period t . The second line shows the mass of mobile firms that entered in $t - 1$ (first summand) minus the mass of mobile firms that relocated in t (second summand).

2.3 Optimal Policy

The government maximizes the expected tax revenue of the current period.³ The tax revenue in period t is given by

$$T_t = \tau_t M_t^M \beta \pi^M + \tau_t n_t^I \alpha \pi^I, \quad (6)$$

where $n_t^I = 1$ if an immobile firm entered in $t - 1$, and as given by eq. (2) otherwise. In its optimization, the government takes into account that its tax rate influences the entry and relocation decisions. Maximizing eq. (6) yields the equilibrium tax rates:

$$\tau_t = \begin{cases} \frac{\alpha + (5\beta - 1)\beta M}{8\beta^2 M} & \text{if immobile firm entered in } t - 1 \\ \frac{\beta\alpha^2(1 + 11\beta) + (5\beta - 1)8\beta^3 M^2 - \alpha^3}{16\beta^2 M(\alpha^2 + 4\beta^2 M)} & \text{if no immobile firm active} \end{cases} \quad (7)$$

To interpret these tax rates, let us first consider how they depend on the characteristics of the jurisdiction. Proposition 1 describes these effects.

Proposition 1 (Optimal tax rates) *The optimal tax rates are given by eq. (7). The optimal tax rate if an immobile firm has entered in the last period increases in α and decreases in β . If no immobile firm is active, the optimal tax rate increases in both α and β .*

Proof. *To be added.* ■

A higher locational advantage for the immobile firms always increases the optimal tax rate $\left(\frac{\partial \tau_t(n^I=0)}{\partial \alpha}, \frac{\partial \tau_t(n^I=1)}{\partial \alpha} > 0\right)$. As the immobile firm cannot relocate, its profits can be highly taxed by the government. This effect already plays a role before the

³In Section 2.4, we consider how the results change if the government also takes future tax revenue into account.

immobile firm enters: As it is possible that an immobile firm with sufficiently low fixed costs enters in the same period, the government already increases the tax rate to profit from this option.

If no immobile firm is active, the tax rate is higher if the mobile firms are more profitable ($\frac{\partial \tau_t(n^I=0)}{\partial \beta} > 0$), as the higher locational rent relative to the tax haven allows the government to tax the mobile firms more without inducing too much relocation to the tax haven. If an immobile firm is active, the tax rate is lower if the mobile firms are more profitable ($\frac{\partial \tau_t(n^I=1)}{\partial \beta} < 0$), as more profitable mobile firms decrease the importance of the immobile firm in the overall tax base.

Let us now see how the tax rate changes after an immobile firm enters a jurisdiction in which no such firm had been active. Proposition 2 summarizes these tax rate changes.

Proposition 2 (Tax rate change after immobile firm entry) *The tax rate increases in the period after an immobile firm has entered. This increase is higher when the immobile firm is more profitable and when there are fewer mobile firms.*

Proof. *To be added.* ■

The government sets a higher tax rate when an immobile firm is already active. As this firm cannot relocate, the overall tax base is less elastic and the government optimally responds by increasing the tax rate. This increase is higher, if the tax base share of the immobile firm is large (either because it has a high locational advantage, or because there are few mobile firms).

2.4 Discussion

This section discusses the robustness of our results when some of the assumptions made in the main model are relaxed.

2.4.1 Forward-looking Government

To be added.

3 Empirical Strategy

Our model has two main implications: First, it finds that governments increase tax rates when an immobile firm enters a jurisdiction (see Proposition 2). Second, it shows

that forward-looking firms anticipate such increases. In particular, the model shows that both mobile and immobile firms prefer to locate in jurisdictions with few other immobile firms, as this decreases the likelihood of future tax rate hikes.

In the following, we empirically test these hypotheses. To do so, we first exploit a very specific setting; that is, the evolution of a new and highly immobile industry within Germany. In a second step, we see whether our results also hold in a more general (and less well-identified) setting.

The setting within Germany is particularly suited for our analysis. In Germany, municipalities have the right to tax corporate profits. This local business tax accounts for roughly 50% of the tax burden on profits. In most municipalities, the tax rate is between 9% and 15%, with a mean of 12%. While the municipalities decide about the tax rate, the tax base is defined by the federal government. Profits are subject to the local business tax in the municipality where the plant (and not, for example, the firm's HQ) is located.⁴ Thus, this setting in Germany provides ample variation in tax rates without regulatory or tax base differences that could be problematic in a cross-country setting.

Our identification strategy relies on changes in the mobility of the tax base. To identify such changes, we consider the market entry of very immobile firms: wind turbines. At the beginning of our sample period in 1998, only very few wind turbines existed in Germany (see Figure 1). The installed turbine capacity grew by more than 400% until 2012 (see Figure 2). In 2012, the profits of wind turbines were a significant source of tax revenue for many rural municipalities – on average about 10% of the local business tax revenue in the municipalities with at least one wind turbine.

[Figure 1 and 2 about here]

The evolution of this new firm type is particularly suitable for our setting for two reasons. Firstly and most importantly, it is extremely costly for wind turbines to relocate. Most of the investment is very specific to the location of the investment. The choice of turbine technology, for example, is strongly influenced by wind conditions at a particular location. Land is often bought or leased at with a very long contract⁵

⁴The reader should not that not the tax rate but the local business tax multiplier is set by the municipality. The calculation of the tax is however straight forward. As a rule of thumb, the multiplier has to be multiplied with 5% before 2008 and 3.5% afterwards to derive the tax rate.

⁵As the lifetime of a wind turbine is 20 years, lease contracts are commonly concluded for 20 years.

Moreover, the actual cost of relocating is extremely high, even if an alternative location for which the particular technology is suited can be found.

Second, the location decision of wind turbines is relatively simple. The most important location specific factor is the wind strength, the two others are local business taxes and agricultural land prices.⁶ Differences in wage costs are not important as there is almost no labor involved in wind electricity generation. Given the limited number of determinants for wind turbines' location decision, municipalities have few options to attract wind turbines, except for the local business tax rate.

In particular, there are no subsidies for renewable energies at the municipal, county or state level. The main subsidy for wind turbines is a guaranteed wholesale price, which is the same across all German municipalities as it is set by the federal government. It stems from the renewable energy act from 2000, which the German government introduced to promote investment into renewable energies as agreed in the Kyoto Protocol and in the Lisbon Treaty. It guarantees a wholesale price above market price for energy produced by renewable energy sources for 20 years after the installation of the plant.⁷ Following the introduction of this law in 2000, the share of electricity produced by renewable energy sources more than tripled until 2012. As the renewable energy act only changes the market price for electricity, it is not relevant for our setting.

4 Municipality Level: Tax Rate Choice and Immobile Firms

In this section, we provide evidence that municipalities raise the tax rate on mobile and immobile firm profits if the tax base share of immobile firms in the municipality increases. We use the tax base share as this captures the number of mobile and immobile firms as well as their profitability.

⁶Wind turbine are mainly build on agricultural land as a minimum distance to populated areas is required.

⁷For further details see Haan and Simmler (2015)

4.1 Data and Descriptive Statistics

To test the predictions of our theoretical model, we use municipality level data for the years 1998 to 2011.⁸ In particular, we use the following variables: the local business tax multiplier, set by the municipality, the local business tax base implied by taxes paid, the population and the share of agricultural land in the municipality. All data is from the German Federal Statistical Offices.

We simulate the tax base from wind turbines using information on the average wind strength in a municipality, provided by the German Weather Service, and information on the location and the technological details of each wind turbine in Germany from the operator database (for further details see Haan and Simmler, 2015).⁹ To capture the incentives at work outlined in the theoretical model, we construct the tax base share of immobile firms by dividing the simulated tax base of wind turbines by the observed local business tax base.¹⁰

Since wind turbines have mostly been build in municipalities with a large share of agricultural land and a sufficiently high wind strength, we construct a suitable control group of similar municipalities. In particular, we use a propensity score matching approach to find a suitable control group (municipalities without wind turbines in 2011). We define the treatment group as municipalities with at least one wind turbine in 2011. We match on the average wind strength 80 meter above ground, the share of agricultural land, the natural logarithm of the local business tax base before 2000, the natural logarithm of the population in 2000, and the local business tax multiplier in 2000. We employ the one to one nearest neighbor matching method. Table A1 in the Appendix provides descriptive statistics for the treatment and control group before and after the matching, suggesting that the difference in observable characteristics are strongly reduced by the matching approach.

Table 1 shows descriptive statistics based on the matched sample. The average

⁸Changes in administrative borders during our sample period are handled as if they had occurred at the beginning of the sample period.

⁹The operator database is a private database, www.betreiber-datenbasis.de.

¹⁰The observed local tax base is deducted from the sum of taxes paid. Note that taxes are paid only in the year after the profits have been generated. Thus, when a municipalities decides about its tax rate in year t (a decision that has to be made by law in January of year t), its information about its overall tax base is based on its tax receipt in year $t - 1$, which in turn are based on the profits in year $t - 2$. We thus divide the profits of wind turbines by the second lag of the overall tax base to generate our tax base share measure.

local business tax multiplier amounts to 340 points, which translate to a tax rate of 17% before 2008. The average population in our sample is 10,000. The average tax base share of immobile firms is 5%, and for the subset of municipalities with at least one wind turbine it is 10%.

[Table 1 about here]

We start with reporting some descriptive evidence on the relationship between the local business tax multiplier and the tax base share of immobile firms. In Figure 3, we plot the kernel density for the local business tax multiplier changes between 2000 and 2011 for treatment and control group. The figure suggest that municipalities with at least one wind turbine in 2011 (treatment group) have increased their tax rate between 2000 and 2011 compared to municipalities with no wind turbines in 2011 (control group). In Figure 4 plots the change in the tax base share of immobile firms and the change in the local business tax points between 2000 and 2011 in a scatter plot. It suggest that municipalities with larger change in the tax base share have increased their local business tax multiplier to a larger extend. If we group the change in the tax base share of immobile firms into 5 intervals of equal length (see Figure 5), the relationship becomes even more obvious. Municipalities for which the tax base share of immobile firms increased by more than 80%-points, raise their tax multiplier by 10%-points relative to municipalities with no wind turbines.

[Figure 3, 4 and 5 about here]

4.2 Estimation Equation and Results

We estimate the following linear specification to provide further evidence that municipalities increase the tax rate on firm profits when the tax base share of immobile firms rises:

$$\tau_{i,t} = c_i + \alpha WS_{i,t} + \beta \frac{T_{I,t}}{T_{0,t}} + \gamma X_{i,t} + \epsilon_{i,t}. \quad (8)$$

The dependent variable is the local business tax multiplier in municipality i at time t . It depends on a municipality specific fixed effect (c_i), on the wind strength as an indicator of the profitability of a wind turbine in the municipality ($WS_{i,t}$), and the tax

base share of immobile firms ($\frac{T_{I,t}}{T_{0,t}}$). We further include time dummies to captures any kind of political cycle as well as the natural logarithm of the population to captures changes in municipalities' size in the estimations. Both variables are included in the matrix X.

We estimate equation (1) in differences to account for municipality specific effects. Further, we employ an instrumental variable estimator to deal with measurement error in the tax base share of immobile firms. This measurement error arises for two reasons. Firstly, we have to simulate the taxable profits of wind turbines. Secondly, the observed tax base varies substantially with the business cycle. The excluded instrument we employ in the IV difference equation is the average wind strength in the municipality, the natural logarithm of the tax base before 2000 and the interaction between the two variables.

This IV approach has the additional advantage that it accounts for a potential delayed impact on the local business tax multiplier choice. To address the impact of potential delays, we also estimate our regression using only the difference between 2000 and 2011. This strategy comes at the cost of a lower number of observations, but has the advantage that the exact timing of firms' and municipalities' decisions does not influence the results.

Table 2 shows the results of our regression analysis. Column (1) and (2) report the estimated coefficients for the first difference estimation, column (3) and (4) for the estimation in differences between 2000 and 2011. Column (1) and (3) present the OLS, column (2) and (4) the IV estimates. Comparing the estimated coefficients across specifications suggest that the imprecise modeling of the timing of the tax rate change biases the OLS but not the IV results. The estimated coefficient in column (2) suggests that an increase in the tax base share of immobile firms by 50%-points causes an increase in the local business tax multiplier by 25%-points. This translate to an increase in the tax rate by 1.25% or 7%.

Our results are not sensitive to the employed matching strategy, in particular if we exclude the tax variables from the matching variable, or exclude treatment observations for which no match can be found within the optimal caliper size (see Table A2, column (1) and (2)).

[Table 2 about here]

5 Firm Level: (Re-) Location Decisions of Mobile and Immobile Firms

As we have seen in the last section, municipalities increase the tax burden on firm profits when the tax base share of immobile firms in the municipality increases. We now investigate to which extent firms anticipate these tax rate changes. We start by analyzing the location decision of wind turbines in Germany on the municipality level, and then study whether mobile firms responded to the entry of wind turbines by relocating.

5.1 Location Decision of Wind Turbines

5.1.1 Data and Descriptive Statistics

We use four sets of variables in the analysis of the location decision of wind turbines. Firstly, information on the installed capacity of wind turbines as well as the number of wind turbines within a municipality in a current year. The data stems from the operator database and is mapped to municipality level by using UTM coordinates for each wind turbine. We aggregate the installed capacity on the municipality level. Secondly, we use the wind strength in the municipality interacted with year dummies to control for the profitability of wind turbines in that particular municipalities.¹¹ Thirdly, we use the local business tax rate, the tax base share of immobile firms, and the interaction between the two variable to test whether firms anticipate future tax rate changes. If they do, the estimated coefficient for the interaction between the tax rate and the tax base share should be negative as a higher tax base share of immobile firms increase the likelihood that tax rates will increase in the future. Finally, we control for agricultural land prices and other municipality characteristics such as the share of agricultural land, the overall size of the municipality and the population density. Since agricultural land prices are affected by the number of wind turbines build as profits are capitalized into land price (see Haan and Simmler, 2015), we use the three year lagged price for building ground to proxy for agricultural land prices. Descriptive statistics for the variable used are shown in Table 3.

[Table 3 about here]

¹¹In a robustness check we also use the simulated profitability of an average technology wind turbine as in the first part of this section. The results are unchanged and available upon request.

5.1.2 Methodology

Following Brühlhart et al. (2012) we estimate a Poisson model on the municipality level.¹² As shown by Guimaraes et al. (2003) and Becker and Henderson (2000) the Poisson model is appropriate to estimate the determinants of the location decision based on the footloose start-up as well of latent start up model. The dependent variable in our main specification is the new installed capacity within a municipality. We prefer the installed capacity to the number of plants, as the installed capacity of a single wind turbine changed remarkably over time due to technological development (see Haan and Simmler, 2015). We report estimated coefficients and not the marginal effects of the Poisson model as the latter are misleading for the interpretation of interaction effects. To interpret the results, we later provide graphical illustrations of the marginal effects.

[Table 4 about here]

5.1.3 Results

Table 4 shows the results for the location decision of wind turbines. The first column reports the results for the baseline specification. The main effect of the tax variable is insignificant, the interaction effect between the tax base share of immobile firms and the local business tax is in contrast precisely estimated and negative. This suggest in line with the theoretical prediction that a larger tax base share of immobile firms amplifies the deterrence effect of taxes. As argued in the theoretical section, we suppose the main reasons to be the information content in the tax base share of immobile firms with respect to the future tax burden.

Before we interpret the results quantitatively we report some robustness tests. In column (2) we include the installed capacity three years before in the estimation to control for time-invariant location specific factors. The results are not affected. In column (3) we include additional interaction effects between the tax variable and other municipality characteristics. If the interaction term with the tax base share of immobile firms just captures heterogeneity in the tax impact which is unrelated to the tax base share of immobile firms, we would expect the coefficient to decrease to zero. However, this is not the case. Interestingly, the two additional interaction effects with the tax

¹²We also estimated a negative binomial model, the results are qualitatively and quantitatively unchanged.

rate are significant. This indicates that the two other variables reveal information on the future tax burden as well.

To assess to which extent empirical estimates may be biased by not accounting for future tax rate changes, column (4) shows our baseline specification without controlling for the tax base share of immobile firms and the interaction term. At least in our particular setting, the bias is substantial, as we do not find a significant impact of the current tax rate on wind turbines' location decision. In the last column, we use the number of wind turbines as dependent variables. Despite our concern about the limited comparability over time due to technological development, results are almost unaffected. Table A3 in the Appendix provides additional robustness checks, confirming the baseline result also when using a binary indicator whether new capacity has been added in a particular municipality or not, or when using growth rates as the dependent variable.

For the quantitative interpretation of the results, we plot the marginal effect for different tax base shares of immobile firms based on specification (1) in Table 6 (see Figure 6). Comparing the marginal effects for a tax base share of 0 and 100% suggest that the negative impact of taxes on wind turbines location decision is multiplied by the factor five if the tax base share increase to 100%. Figure 7 shows the marginal effect based on a more flexible specification where we use interaction effects with dummy variables for five quantiles of the tax base share of immobile firms. The general shape of the curve as well as the absolute size of the impact is basically unchanged.

[Figure 6 and 7 about here]

Summing up, there is strong evidence that firms care about the future expected tax burden and less about the current tax rate. Based on the location decision of wind turbines, we find that only the future tax burden affects the location decision of wind turbines but not the current tax rate.

5.2 Re-Location Decision of Mobile Firms

To be added.

6 General Setting

Are our results limited to the particular setting we exploit for identification? To answer this question, we construct a general mobility indicator for firms located within a municipality and use this indicator to explain jurisdictions' tax rate choice in the cross section. Based on the theoretical prediction and the results obtained for the tax base share of wind turbines, we expect that municipalities in which the average firm mobility is low set a higher local business tax rate.

The mobility indicator is based on the observed relocation decision of firms in the financial statements database DAFNE between 2006 and 2010. In a first step, we construct the average probability that a firm in a particular industry (at the 2-digit level) relocates. In a second step, we average the probability for all firms located in a particular municipality in 2009. The resulting average firm mobility indicator amounts in our sample of municipalities to 1%. Thus, 1% of firms in the average municipality are likely to relocate within one year. The reader should not that our mobility indicator is a lower bound for firm mobility, as firms might not relocate if municipalities do not raise the tax rate.

To assess whether our average firm mobility indicator is able to explain municipalities' tax rate choice, we regress the tax multiplier set by the municipality on the mobility indicator and the control variables. These are the natural logarithm of population, the unemployment rate, the household income, and the average wage income. Moreover, we include the seat share of the political parties in the municipality council as they decide on the local business tax multiplier. Further, we include the natural logarithm of total assets in the municipality based on 2009 data. Note that we only include municipalities in the analysis for which at least 10 firms are observed in 2009. We do so to reduce the noise in the mobility indicator. Descriptive statistics for the sample used are shown in Table 5.

[Table 5 about here]

Table 6 reports the estimated coefficient of the regression analysis for the year 2005. Column (1) reports the estimated coefficients without any control variables, in column (2) we add the above mentioned control variables. In column (3) we further include the asset weighted share of firms in each 2 digit industry in the municipality. Finally, in column (4) we use the 3 digit industry mobility instead of the 2 digit industry indicator. The estimated coefficient for the mobility indicator is in all specifications negative and

significant at the 1% level. Thus, a higher firm mobility is associated with a lower tax rate in a municipality. The size of the coefficient decreases slightly when adding control variables. Based on the estimates shown in column (3), an increase in firm mobility by 1%-point, decrease the tax multiplier by 50%-points. This is very similar to the results obtained in the wind turbine setting. The increase in the tax base share of immobile firms by 100%, which caused an increase in the multiplier by 50% points as well, can be seen as a reduction in the firm mobility from the average value which is 1% to 0.

[Table 6 about here]

7 Conclusion

Governments face commitment problems in their tax policy choice due to the presence of firms with high relocation costs. Although low tax rates attract both firms with low and high relocation costs, governments face the incentive to increase tax rate on immobile firm profits once these firms have made their location decision.

We show in this paper that firms anticipate government behavior by adjusting the information content of the current tax rate with respect to the future tax burden. This implies that empirical estimates on the impact of tax policy on firm' decision using the current tax rate to approximate the future tax burden are likely biased. Another implication of our work is that firm mobility influence the impact of tax policy on firms' location decision, as firms prefer to locate in jurisdictions with many highly mobile firms as they continue to pressure government for low tax rates.

Our analysis can be extended in various directions. Mobility is only one of many predictors of corporate tax rates. Future studies could, for example, consider other determinants of corporate tax rates such as revenue needs or political preferences and determine if firms also anticipate their influence on the corporate tax rate.

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Tables

Table 1: Descriptive Statistics: Municipality Level Variables

	Mean	P25	P50	P75	SD
Local business tax mutltiplier	341	310	340	360	39
Wind strength	5.68	5.19	5.59	6.05	0.73
Profitability wind turbine	2.97	2.36	3.07	3.72	1.15
Share tax base immobile firms in %	4.64	0	0	0.68	15.29
Share tax base immobile firms II in %	6.9	0	0	0.95	20.96
Population	10572	1775	5146	13131	16503
Change local business tax multiplier	1.85	0	0	0	8.49
Change profitability wind turbine in %	13	1.11	6.39	20.7	63.26
Change share tax base immobile firms in %	0.32	0	0	0	6.15
Change share tax base immobile firms II in %	0.97	0	0	0	6.42
Growth rate population in %	-0.24	-0.92	-0.11	0.42	3.72
<i>Municipalities with at least 1 plant</i>					
Local business tax multiplier	348	320	340	380	41
Share tax base immobile firms in %	9.52	0	0.78	6.77	20.82
Share tax base immobile firms II in %	14.15	0	1.05	9.73	28.26
Change local business tax multiplier	2.41	0	0	0	9.43
Change share tax base immobile firms in %	0.83	-0.25	0.01	0.57	9.94
Change share tax base immobile firms II in %	1.99	0	0	0.26	9.09

Notes: The sample includes 40,578 municipality-year observations for 2000 to 2011. The number of municipalities-year observations with at least one plant is 19,786. The tax base share of immobile firms is defined as the twice lagged simulated tax base divided by the observed tax base. The tax base share of immobile firms II is defined as the twice lagged simulated tax base divided by the observed tax base before 2000.

Source: Authors' calculations based on Statistik Lokal, 1998 to 2011, the German Weather Service, and the operator database, 1990 to 2011.

Table 2: Estimation Results: Municipalities' Tax Rate Choice and the Tax Base Share of Immobile Firms

Model	(1)	(2)	(3)	(4)
Dep. Var.	Change local business tax multiplier			
	yearly basis		between 2000 and 2011	
Method	OLS	IV	OLS	IV
d.Return WT	0.163*	0.205**		
	(0.096)	(0.101)		
d.Return WT, 2000-11			0.723*	0.418
			(0.433)	(0.480)
d.Share TaxBase IF	2.764**	52.906***		
	(1.253)	(19.524)		
d.TaxBaseShare IF, 2000-11			11.501***	50.648**
			(3.505)	(22.058)
d.log(Pop.)	0.785	0.872		
	(0.724)	(0.848)		
d.log(Pop.), 2000-11			-3.890	1.910
			(6.708)	(7.047)
R^2	0.026	-0.089	0.134	0.090
Kleinberg-Paap rank statistics		100		76
Observations	40,578	40,578	3,388	3,388

Note: Estimations are at the municipality level. The dependent variable is the municipality specific local business tax multiplier. D. indicates differences. In column (1) and (2) it is the first difference, in column (3) and (4) the difference between 2000 and 2011. WT stands for wind turbine and IF for immobile firms. Standard errors, shown in parenthesis, are robust to heteroscedasticity and clustered at the municipality level. ***, **, * indicate significance at the 1%, 5%, 10% levels. Each regression includes a full set of time dummies (not reported). In column (2) and (4) we treat the change in the tax base share of immobile firms as endogenous. In both specifications, we use the wind strength on the municipality level, the natural logarithm of the tax base before 2000, and the interaction between the two variables as excluded instruments.

Source: Authors' calculations based on the operator database, 1990 to 2011, Statistik Lokal, 2000 to 2011, and the German Weather Service.

Table 3: Descriptive Statistics: Wind Turbines

	Mean	P25	P50	P75	SD
Wind strength in m/s	5.53	5.05	5.44	5.94	0.68
Profitability wind turbine	2.75	2.14	2.84	3.55	1.18
Installed capacity	1565	0	0	0	7305
New installed capacity	173	0	0	0	1591
Number of plants	1.5	0	0	0	7.1
Number of new plants	0.1	0	0	0	0.9
Local business tax	14.9	12.3	15	17	2.7
Share tax base immobile firms	4.13	0	0	0	17.77
Share tax base immobile firms II	4.09	0	0	0	17.61
Area size	30	9	18	38	34
Population	6583	707	1828	5317	26015
Population/area size	192	56	101	206	274
Price square meter building land	103	43	73	132	93

Notes: The sample includes 128,554 municipality-year observations for 2000 to 2011. The tax base share of immobile firms is defined as the twice lagged simulated tax base divided by the observed tax base. The tax base share of immobile firms II is defined as the twice lagged simulated tax base divided by the observed tax base before 2000. Price of building land is observed on the county level.

Source: Authors' calculations based on Statistik Lokal, 1998 to 2011, and the operator database, 1990 to 2011, and the German Weather Service.

Table 4: Estimation Results: Location Decision of Wind Turbines

Model	(1)	(2)	(3)	(4)	(5)
Dep. Var.	New installed capacity			New plants	
Wind strength 80m*D(2000)	0.506*** (0.081)	0.520*** (0.079)	0.522*** (0.079)	0.698*** (0.079)	0.459*** (0.076)
....					
Local business tax (LBT)	0.026 (0.016)	0.024 (0.016)	-0.085** (0.037)	0.001 (0.016)	0.039** (0.017)
LBT*TaxBaseShare IF	-0.084*** (0.025)	-0.076*** (0.026)	-0.084*** (0.028)		-0.084*** (0.025)
LBT*Share agric. land			0.001** (0.001)		
LBT*L3.Price building land			0.000*** (0.000)		
TaxBaseShare IF	2.860*** (0.365)	2.395*** (0.388)	2.513*** (0.411)		2.973*** (0.360)
log(area size)	1.008*** (0.031)	0.922*** (0.032)	0.916*** (0.032)	1.033*** (0.032)	1.007*** (0.029)
Population density	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)
Share agric. land	0.018*** (0.001)	0.018*** (0.001)	-0.002 (0.008)	0.019*** (0.001)	0.018*** (0.001)
L3.Price building land	-0.005*** (0.000)	-0.005*** (0.000)	-0.011*** (0.002)	-0.005*** (0.000)	-0.005*** (0.000)
L3.Installed capacity wind turbines		0.000*** (0.000)	0.000*** (0.000)		
log-likelihood	-72,910,036	-72,274,989	-72,185,002	-75,497,797	-48,581
Observations	128,554	128,554	128,554	128,554	128,554

Notes: Estimations are at the municipality level for the years 2000 to 2011. Estimated coefficients based on Poisson models are shown. The dependent variable is the new installed capacity (column (1) to (4)) and the number of new wind turbines (column (5)) in a particular municipality and year. IF stands for immobile firms. Price of building land is observed at the county level. Standard errors, shown in parenthesis, are robust to heteroscedasticity and clustered at the municipality level. **,*,* indicate significance at the 1%,5%,10% levels.

Source: Authors' calculations based on Statistik Lokal, 1998 to 2011, the operator database 1990 to 2011 and the German Weather Service.

Table 5: Descriptive Statistics: Municipality Level Mobility Analysis 2005

	Mean	P25	P50	P75	SD
Local business tax multiplier	335	310	330	350	36
Mobility Indicator 2digit industry	1.01	0.95	0.98	1.02	0.12
Mobility Indicator 3digit industry	1.01	0.94	0.97	1.03	0.15
log(population)	8	7	8	9	1
Unemployment rate	6	4	5	7	3
Household income	1543	1442	1543	1639	177
Share of employees in R&D	8	2	5	10	11
log(total assets)	5	4	5	6	1
Seats CDU	31.29	0	35.17	47.83	23.13
Seats SPD	17.62	0	15	30	17.55
Seats left wing party	1.95	0	0	0	6.2
Seats right wing party	1.88	0	0	0	5.43
Seats green party	1.4	0	0	0	3.5

Notes: The sample includes 5,930 municipality observations for 2005. Only municipalities for which at least 10 firms in 2009 are observed in the DAFNE database are included. The average firm mobility indicator is based on the firm relocations observed in the DAFNE database. We calculate industry average probabilities and calculate the average mobility of firms in a particular municipality. Unemployment rate, average household income and share R&D employees are on the county level.

Source: Authors' calculations based on Statistik Lokal, 1998 to 2011, and the operator database, 1990 to 2011.

Table 6: Estimation Results: Municipalities' Tax Rate Choice and Firm Mobility

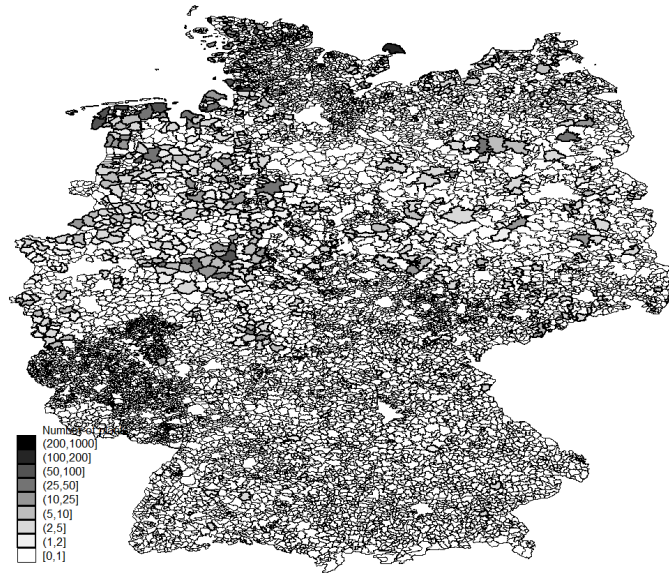
Model	(1)	(2)	(3)	(4)
Dep. Var.	Local business tax multiplier			
Av. firm mobility 2digit industry	-89.916*** (5.896)	-61.241*** (6.673)	-49.015*** (9.194)	
Av. firm mobility 3digit industry				-56.618*** (5.442)
log(population)		15.620*** (0.772)	15.686*** (0.801)	15.451*** (0.769)
Unemployment rate		3.144*** (0.299)	3.260*** (0.308)	3.263*** (0.298)
Av. household income		0.008** (0.004)	0.011*** (0.004)	0.009** (0.004)
Share R&D employees		-0.072** (0.033)	-0.065** (0.032)	-0.071** (0.033)
log(total assets)		-1.957*** (0.436)	-2.264*** (0.510)	-1.955*** (0.435)
Seat share CDU		-3.275 (2.025)	-1.922 (2.001)	-3.575* (2.022)
Seat share SPD		-6.313** (2.585)	-7.831*** (2.615)	-6.678*** (2.584)
Seat share left wing party		-76.428*** (10.135)	-70.908*** (10.242)	-77.097*** (10.107)
Seat share right wind party		21.637** (9.566)	21.641** (9.571)	21.578** (9.550)
Seat share green party		93.683*** (12.838)	98.257*** (12.726)	94.638*** (12.818)
R^2	0.041	0.281	0.302	0.284
Observations	5,930	5,930	5,930	5,930
Share firms 2digit industry			x	

Note: Estimations are at the municipality level for the year 2005. The dependent variable is the municipality specific local business tax multiplier. Only municipalities for which at least 10 firms in 2009 are observed in the DAFNE database are included. Unemployment rate, average household income and share R&D employees are on the county level. Standard errors, shown in parenthesis, are robust to heteroscedasticity. ***, **, * indicate significance at the 1%, 5%, 10% levels.

Source: Authors' calculations based on Statistik Lokal, 2005, and the DAFNE database, 2006 to 2010.

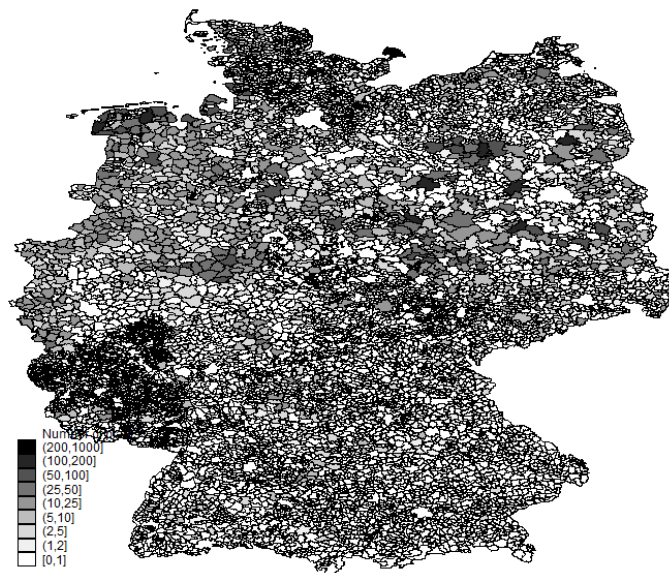
Figures

Figure 1: Number of Wind Turbines in 1998



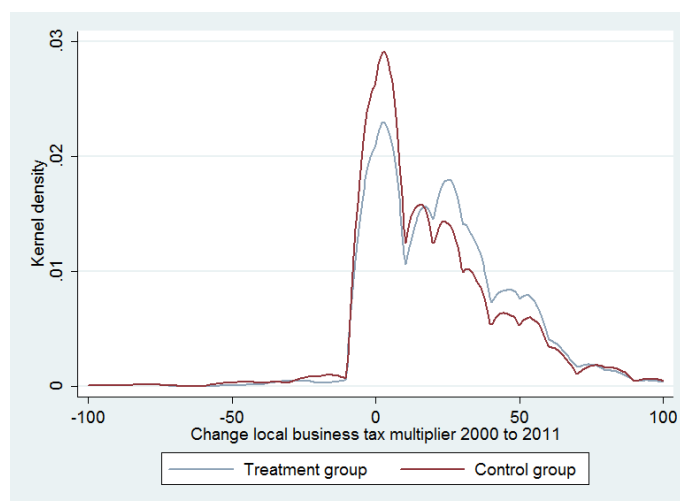
Source: Own calculations based on data of the operator database 1990 to 1998.

Figure 2: Number of Wind Turbines in 2011



Source: Own calculations based on data of the operator database 1990 to 2011.

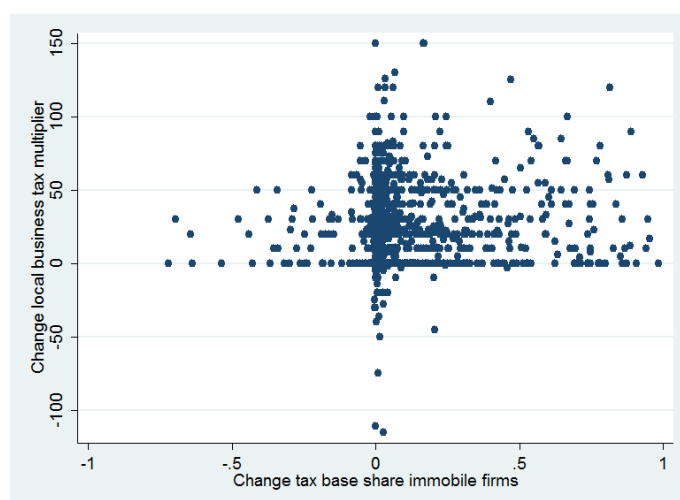
Figure 3: Kernel Density for Local Business Tax Multiplier Changes for Municipalities with (Treatment) and without Wind Turbines (Control Group) in 2011



Notes: Treatment group includes municipalities with wind turbines in 2011, control group includes municipalities with similar characteristics as the treatment group but with no wind turbines in 2011. Control groups municipalities are selected using propensity score matching.

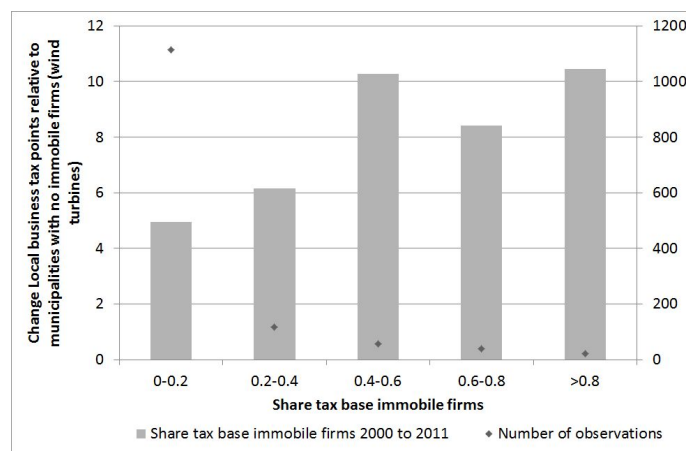
Source: Own calculations based on data of the operator database 1990 to 2011 and Statistik Lokal 2000 to 2011.

Figure 4: Scatter Plot for Change of Local Business Tax Multiplier and Change in the Tax Base Share of Immobile Firms between 2000 and 2011



Source: Own calculations based on data of the operator database 1990 to 2011, Statistik Lokal 2000 to 2011 and the German Weather Service.

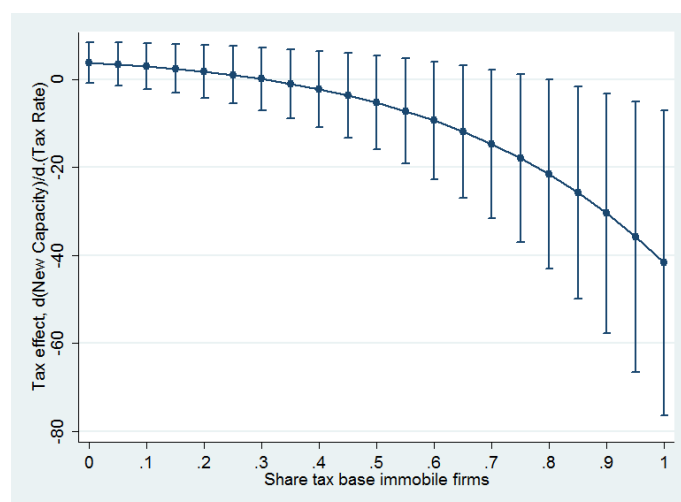
Figure 5: Changes of Local Business Tax Multiplier for different Intervals of Changes of the Tax Base Shares of Immobile firms between 2000 and 2011



Notes: The bars indicate the change in the local business tax multiplier, the points the number of municipalities within a particular class of changes of the tax base share of immobile firms.

Source: Own calculations based on data of the operator database 1990 to 2011, Statistik Lokal 2000 to 2011 and the German Weather Service.

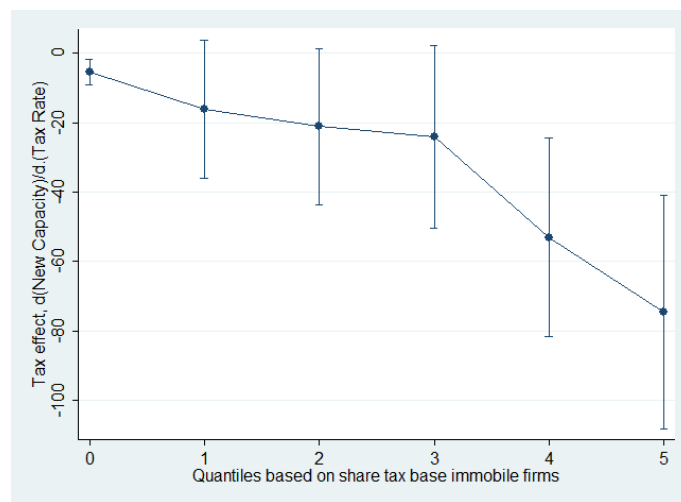
Figure 6: Implied Tax Effects (Poisson Estimates)



Notes: The graph shows the effect of a percentage-point increase in a location's tax rate on the newly installed capacity within the jurisdiction for different tax base shares of immobile firms in the jurisdiction. The underlying computations are based on the coefficients and standard errors reported in Table 4, column 1. Vertical lines represent 95% confidence intervals.

Source: Own calculations based on data of the operator database 1990 to 2011, Statistik Lokal 2000 to 2011 and the German Weather Service.

Figure 7: Implied Tax Effects (Poisson Estimates with 5 Quantiles)



Notes: The graph shows the effect of a percentage-point increase in a location's tax rate on the newly installed capacity within the jurisdiction for different tax base shares of immobile firms in the jurisdiction. The underlying computations are based on the a specification with interaction effects with the local business tax rate and dummies for the 5 quantiles. Vertical lines represent 95% confidence intervals.

Source: Own calculations based on data of the operator database 1990 to 2011, Statistik Lokal 2000 to 2011 and the German Weather Service.

Appendix: Additional Tables

Table A1: Descriptive Statistics: Treatment and Control Group Municipality Level 2000

	Control Group				Treatment Group	
	Before Matching		After Matching		Mean	SD
	Mean	SD	Mean	SD		
Local business tax multiplier	321	33	330	34	334	40
Wind strength	5.48	0.67	5.68	0.86	5.68	0.57
Share agricultural land	0.56	0.21	0.59	0.2	0.62	0.24
Tax base mobile firms	282	1063	753	1859	813	2581
log(Tax base mobile firms)	3.49	2.29	4.81	2.22	5.07	2.07
Population	3966	7391	9607	12864	11579	20,322
log(Population)	7.39	1.33	8.38	1.36	8.55	1.35

Notes:: The number of observations in the control group before applying nearest neighbor matching is 8,316. The number of observations in the treatment and control group after matching is 1,694. The tax base of mobile firms is the observed tax base in a municipality before 2000.

Source: Authors' calculations are on Statistik Lokal, 2000, the German Weather Service and the operator database, 1990 to 2000.

Table A2: Estimation Results: Sensitivity Analysis Municipalities' Tax Rate Choice

Model	(1)	(2)	(3)
Dep. Var.	Change local business tax multiplier		
Matching	without tax variables	with opt. caliper	as baseline
d.Return WT, 2000-11	0.390 (0.501)	0.145 (0.536)	0.682 (0.434)
d.TaxBaseShare IF, 2000-11	76.894*** (26.257)	49.269** (24.618)	
0.2 > d.TaxBasShare IF, 2000-11 > 0			1.931** (0.955)
0.4 > d.TaxBasShare IF, 2000-11 > 0.2			3.537 (2.303)
0.6 > d.TaxBasShare IF, 2000-11 > 0.4			6.668* (4.049)
0.8 > d.TaxBasShare IF, 2000-11 > 0.6			6.837 (4.477)
d.TaxBasShare IF, 2000-11 > 0.8			7.565 (6.442)
d.log(Pop.), 2000-11	2.643 (7.597)	0.236 (7.849)	-4.141 (6.731)
R^2	0.006	0.089	0.133
Kleinberg-Paap rank statistics	47	61	
Observations	3,388	2,782	3,388

Note: Estimations are at the municipality level. The dependent variable is the municipality specific local business tax multiplier. D. indicates differences between 2000 and 2011. WT stands for wind turbine and IF for immobile firms. Standard errors, shown in parenthesis, are robust to heteroscedasticity and clustered at the municipality level. ***,**,* indicate significance at the 1%,5%,10% levels. Each Regression includes a full set of time dummies (not reported). In column (1) and (2) we treat the change in the tax base share of immobile firms as endogenous. In both specifications, we use the wind strength on the municipality level, the natural logarithm of the tax base before 2000, and the interaction between the two variables as excluded instruments. In column (1) we exclude the tax variable from the matching variables. In column (2) we only used treatment observations for which a nearest neighbor is found within the optimal caliper size.

Source: Authors' calculations based on Statistik Lokal, 2000 to 2011, and the operator database, 1990 to 2011.

Table A3: Estimation Results: Sensitivity Analysis Wind Turbines Location Decision

Model	(1)	(2)	(3)
Method	OLS		Probit
Dep. Variable	log(new cap.)	log(growth rate new cap.)	D(new capacity)
Local business tax (LBT)	-0.091*** (0.010)	-0.032* (0.017)	0.070*** (0.005)
LBT*TaxBaseShare IF	0.019 (0.018)	-0.115*** (0.025)	-0.025** (0.012)
TaxBaseShare IF	-0.395 (0.261)	0.516 (0.378)	1.115*** (0.169)
R^2	0.097	0.304	
log-likelihood			-13,746
Observations	3,733	2,692	128,554
Control Variables	YES	YES	YES

Note: Estimations are at the municipality level for the years 2000 to 2011. Estimated coefficients are shown based on OLS (column (1) and (2)) and probit regressions (column (3)). The dependent variable is the new installed capacity (column (1) to (4)) and the number of new wind turbines (column (5)) in a particular municipality and year. Each regression includes a full set of time dummies (not reported). Standard errors, shown in parenthesis, are robust to heteroscedasticity and clustered at the municipality level. **,*,* indicate significance at the 1%,5%,10% levels. *Source:* Authors' calculations based on Statistik Lokal, 1998 to 2011, the operator database 1990 to 2011 and the German Weather Service.