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# The Effect of Land Consumption on Municipal Tax Revenue: Evidence from Bavaria

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**Abstract**

This paper aims to quantify the municipal tax revenue effects of built-up area increases. The assumed existence of these effects is one of the key reasons for ongoing land consumption on the side of the municipalities. Some previous case studies however suggested that these effects might be not large enough especially in rural municipalities and would thus make land development not profitable. We estimate the effect of built-up industrial and commercial (BIC) area change on the business tax revenues in cross-sectional instrumental variable (IV) estimations. Based on detailed data for Bavaria, we find a significant and positive tax revenue effect of an increase in municipal BIC area. There exist strong differences in the size of this effect between urban and rural municipalities. The largest effects are generated by the BIC area in the large cities and become substantially smaller when these are dropped from the sample. Based on these findings, we reflect on the tradable planning permits (TPP) scheme recently discussed in the land use literature in the context of policies aiming to limit land consumption. Furthermore, we relate our estimates to the average municipal costs for land development and execute a number of robustness checks.

*JEL classification*: H21; H25; H70; H71; R14; R52

*Keywords*: tax revenues; municipal taxes; land consumption; instrumental variable regression

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# INTRODUCTION

In the year 2000, the consumption of new land for settlement and traffic purposes in Germany reached 129 hectares per day (German Federal Government, 2002). As a reaction, the German national sustainability strategy addressed this issue and set a goal of limiting built-up area and transport infrastructure expansion by 30 hectares per day until 2020 (ibid). The reason for this policy action was that Germany, as many other densely populated countries, aims to slow down the conversion of undeveloped land and to preserve open areas (Henger and Bizer, 2009). In the years 2012-2015, however, daily land consumption for settlement and traffic purposes in Germany still amounted to about 66 hectares (German Federal Statistical Office, 2015).

Also other European countries such as Austria and Switzerland introduced policies to reduce land consumption. Austria set a goal of 2.5 hectares per day until 2010 for the consumption of new land. However, in 2016, land consumption in Austria increased at a rate of 15 hectares per day (Environment Agency Austria, 2016). In Switzerland, settlement area should be stabilized at 400 $m^2$ per capita (Swiss Federal Council, 2012). The EU as a whole aims to reach zero net consumption of new land until 2050 (European Commission, 2011). The current land consumption trends however cast doubts on whether these political goals will be reached.

An important reason for the ongoing consumption of new land in the developed countries like Germany (despite low population growth) is the competition for tax revenues, jobs and residents between municipalities (Krumm, 2001; Pagano, 2003; Brunori, 2004; Bizer, 2005; Zollinger and Seidl, 2005; Perner, 2006; Wassmer, 2008; Nuissl and Schroeter-Schlaack, 2009). The municipal governments often see conversion of open area and land development as an instrument to attract new firms and residents and thus to achieve additional tax revenues (Ladd, 1998; Michaelis, 2002; Wassmer, 2002; Wassmer, 2003; Bizer, 2005; Gottlieb, 2006; Henger and Thomä, 2009; Paulsen, 2013; Brandt, 2014). This is particularly the case in Germany where local authorities are responsible for the development and the allocation of land (Siedentop et al., 2009; Henger and Thomä, 2009).

Although the tax revenue impact of land consumption[1] is commonly assumed intact and strong (Lucy and Fisher, 2000; Wassmer, 2002; Reidenbach et al., 2007; European Commission, 2012), to the best of our knowledge, there are no empirical estimates of this relationship for a large sample of municipalities. Related research usually takes the form of case studies. For example, the cost of community service studies (COCS) in the U.S. usually contain calculations for the fiscal balance of individual land consumption projects (Leighton and Meyer, 1999; Dorfman, 2006). In Germany, relatively few such case studies exist (e.g. Gutsche, 2003; Krause-Junk, 2007; Bizer, 2005; Artmann, 2013).

An indication that the assumed link between land consumption and tax revenues might not be generally valid comes e.g. from Mönnich (2005) or Sbosny and Siebert (2010). These authors refer to a situation where neighboring municipalities simultaneously choose to convert open areas in order to attract firms and residents as "ruinous competition" that leaves many municipalities with losses rather than with profits. Other authors show in particular that there is a general overestimation (on the side of the municipalities) of the effects of new industrial and commercial sites on tax revenues (Bade et al., 1993; Gutsche, 2003; Krause-Junk, 2007; Reidenbach et al., 2007; Schweppe-Kraft et al., 2008; Wixforth, 2009). The latter types of land use constitute the focus of this paper.

The conversion of land for industrial and commercial use is one component of the overall land consumption, from which the German municipalities may directly expect future tax revenues. After starting their business activities, most newly settled companies in Germany are obliged to pay local business taxes. These business taxes constitute a large share of the municipal budgets. For other types of land use, e.g. housing, transport or recreation, the connection to the municipal tax revenues is not as direct. In order to test the validity and the strength of the link between land consumption and municipal tax revenues, this paper thus focuses on the tax effects of changes in the built-up industrial and commercial (BIC) area. This indicator shows the actual land consumption, i.e. realizations of construction projects for industrial and commercial purposes. We are the first that bring it into the discussion.

[1] By land consumption in this paper we mean actual built-up area and transport infrastructure expansion.

For our analysis, we chose the federal state of Bavaria because data availability compared to the other German states is particularly good. Furthermore, Bavaria consists of a high number (2054) of municipalities, which are very heterogeneous in size, population density, industry structure etc. A German-wide analysis was not possible due to lack of synchronized land consumption data. The consumption of new land in Bavaria accounts to about 22 % of the German total (cf. Bavarian State Office for the Environment, 2015).

From the economic theory viewpoint, this paper is connected to the public choice literature. An assumption taken by some authors within this field is that the municipalities' aim is to maximize their tax revenues. This assumption is taken e.g. in the Leviathan theory developed by Brennan and Buchanan (1980), which was analyzed further by Edwards and Keen (1996) and Feld (2014). According to this theory, local policies are chosen strategically in order to attract mobile production factors. The more municipalities exist, the less expensive is emigration of firms and households. The openness leads to competition between local governments (Feld, 2014). A prediction of this theory, put in the context of our paper, is that a municipality would actively develop land or allocate open space for industrial and commercial purposes if this will attract companies, which the municipal government can tax (Henger and Thomä, 2009; Paulsen, 2013).

To achieve the German 30-hectares goal, a tradable planning permit scheme (TPP) is discussed in the literature (Bovet, 2006; Schweppe-Kraft et al., 2008; Henger and Bizer, 2010). These authors argue that TPP is an appropriate economic instrument, which can be more effective than stricter planning controls to manage land consumption. The TPP approach is based on a cap-and-trade principle to meet predefined goals. Under such a scheme, areas with higher land demand would tend to buy planning permits from areas with less land demand once their contingents are exhausted and as long as it is profitable to do so. This coordination process under the TPP scheme would lead to an efficient allocation based on the municipalities' willingness to pay[2].

[2] For a critical evaluation on the TPP scheme, see Davy (2009). For a broader insight on development rights as a market-based land use planning tool, see e.g. Linkous (2017).

Given the large literature on agglomeration effects in regard to land use and land prices (e.g. Verhoef and Nijkamp, 2008; Lin and Ben, 2009; Combes et al., 2013; Ahrend and Lembcke, 2016), we can expect that the tax effects from land consumption (and willingness to pay for planning permits) are higher in urban compared to rural areas. Within urban areas, these effects are arguably higher in more densely populated cities. A particular research question in this paper focuses on quantifying tax revenue effects of land consumption in different municipality types.

This paper thus seeks to fill the gap of an empirical study that investigates the tax revenue effects of land consumption for a large sample of municipalities. Specifically, we aim to estimate the effect of the BIC area changes on the business tax revenues in cross-sectional IV estimations. We use data on municipalities in Bavaria for the period 2009-2013. We find a positive and significant effect of the BIC area on the business tax revenues in Bavarian municipalities. Furthermore, significant differences between more and less densely populated municipalities are detected. Identified heterogeneity reveals where land consumption is more and less profitable for municipalities. These findings enable us to draw conclusions on the possibility of achieving land saving via a tradable planning permits (TPP) scheme. Furthermore, we relate our estimates to the costs of land development and reflect on the validity of the "ruinous competition" hypothesis.

The paper proceeds as follows. In the next section, we describe the institutional background, which is followed by a section presenting the data used. The fourth section examines the empirical method and the identification challenges. Section 5 presents and discusses the key results, followed by robustness checks in section 6. Section 7 discusses the findings in the light of land development costs and tradable planning permits, and section 8 concludes.

## INSTITUTIONAL BACKGROUND: MUNICIPAL BUSINESS TAXES AND LAND USE PLANNING

According to Article 106 (6) of the German constitutional law, municipal governments possess tax sovereignty on impersonal taxes such as property and business taxes (Rudzio, 2011). As far as business tax is concerned, the German Business Tax Act (*Gewerbesteuergesetz*) determines the general assessment base and a common part of the tax rate (*Steuermesszahl)*. The actual tax rate is formed by multiplying the common part by a tax multiplier, which is set by every municipality. This tax multiplier shows a large variation across municipalities ranging from 230 to 490 within Bavaria.

The business tax is levied on domestic businesses – with an exception of freelancers, public and agricultural businesses. Due to determination rules, only businesses with positive earnings are taxed.[3] In the case that a company owns several business establishments in different municipalities, business profits are split over all establishments depending on the total wage bill. This means, even if a company makes no profit at the local branch, the municipality still gets tax payments from total profits of the company's other branches (Reidenbach et al., 2007).

In Bavaria in the study period, about 45 percent of all commercial businesses had a positive tax rate (Bavarian State Office for Statistics, 2012). The business tax accounted for more than one third of all municipal revenues (Bavarian State Office for Statistics, 2013).

An important task of the municipal planners is to set up a land use plan, even though it is not mandatory. The German Building Code indicates that the main task of the urban land use planning is to arrange and manage the usage of properties and its construction design (Article 1). This land use plan is the only planning document with a direct legal effect for municipalities and defines clear rules for the allocation of building rights (Perner 2006). The municipalities are free in adopting this plan due to their planning autonomy.

[3] By a business tax levy (*Gewerbesteuer-Umlage*) the municipalities pass a part of business tax revenues to the federation and the federal states – which yields the net value

## DATA SOURCES

*Built-up industrial and commercial area*

The federal state of Bavaria with its 2,056 politically independent municipalities is the largest German federal state (70,550 square kilometers (km$^2$) or 7.055 million hectare) and the second most populous state (12.44 million inhabitants). In addition, it has 199 unincorporated areas that mainly contain lakes and forests - where no land is used for industrial and commercial purposes. Those areas were excluded from our analysis.

Data on BIC area in Bavaria stem from the IOER Monitor[4], which is based on official topographic base data, the so-called ATKIS Basic Digital Landscape Model (ATKIS Basic DLM) of the Authoritative Topographic and Cartographic Information System (*Amtliches Topographisch-Kartographisches Informationssystem*, ATKIS). It is the most important input dataset for the IOER Monitor land-use/ land-cover indicators (Krüger et al., 2013; Meinel and Krüger, 2014).

Geometrically and semantically, the ATKIS Basic DLM is the most precise topographical dataset available for Germany (Röber et al., 2009). The update cycles vary among the federal states. In the study period, the data actuality for Bavaria is two years delayed.

We focus on the change in the BIC area, which solely describes land consumption (realized demand) for industrial and commercial purposes. Out of the daily land consumption of about 15 hectares in Bavaria in 2013 – following the IOER Monitor- settlement area (including recreational area and other open space area) accounts for about 70 %, while traffic area makes up the rest of this daily increase. The BIC area belongs to the settlement area and accounts for about 20 % of its daily increase.[5]

Due to lower frequency of data updating before 2009, the dataset for Bavaria used in this paper covers the years 2009 to 2013 only. For the years before 2009, also several other necessary control variables

[4] IOER. Monitor of Settlement and Open Space Development. Online: www.ioer-monitor.de.

[5] Differences in the size of different area categories between the IOER Monitor and the official statistics of Bavaria exist due to varying survey procedures. As mentioned above the ATKIS Basic DLM is the basis for the IOER Monitor, in contrast the official statistics uses real estate cataster data.

from the Genesis Database[6] were not available. Because the BIC area data are not reported strictly every year, we also preferred to estimate a regression model in 2009-2013 differences, rather than a panel regression.

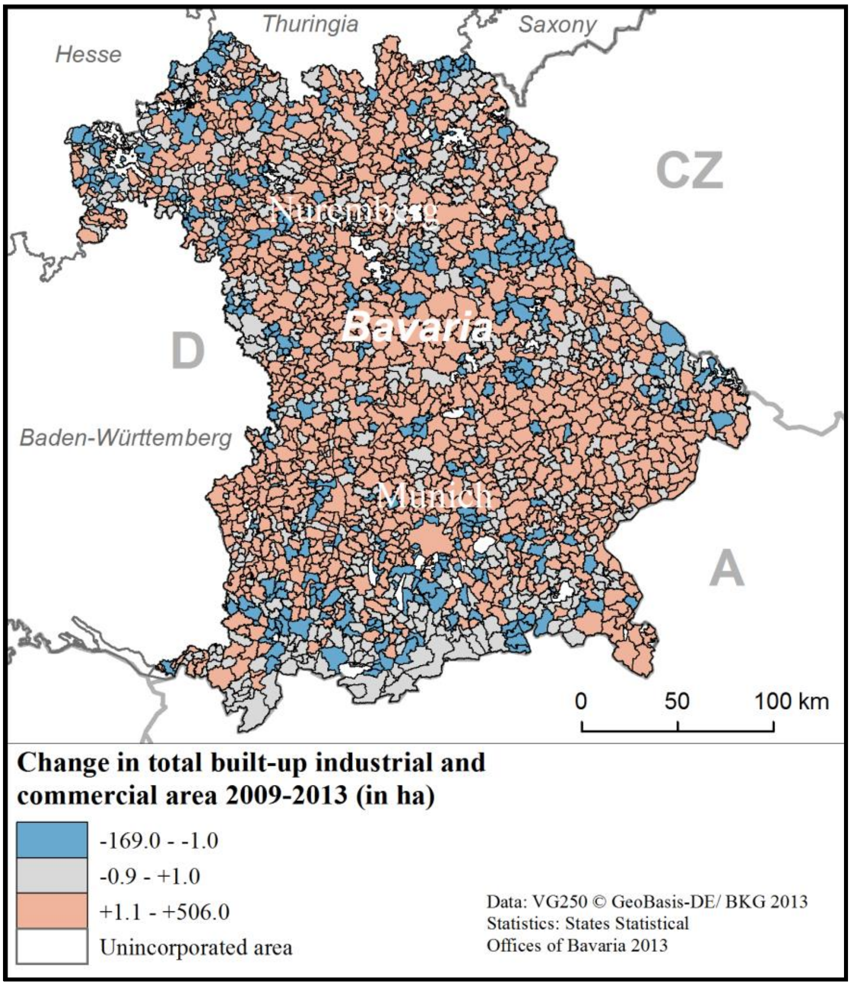



**Figure 1.** Map of Bavarian municipalities and the change of BIC area in the period 2009-2013

Figure 1 shows the changes in the BIC area in the federal state of Bavaria between 2009 and 2013. The white spots are unincorporated areas. We highlight the areas that built up more than 1.1 ha (orange), experienced an absolute change of less than 1 ha (grey) and regained more than 1 ha (blue) of BIC area in this period. The map indicates that new land consumption is a phenomenon, which is not specific to certain parts of Bavaria only; rather, it is quite widespread.

[6] Municipal data was made available from the Genesis database Bavaria. It is a database, which contains official statistical data of the Bavarian State Office for Statistics.
Online: https://www.statistikdaten.bayern.de/genesis/online/data?operation=sprachwechsel&option=en.

In the regression analysis that follows, business tax revenues are the dependent variable. The BIC area is the main independent variable. We expect this variable to have a positive impact, because it accounts for the companies' settlement and enlargement. The more industrial and commercial area is used, the higher should be the business tax revenue impact.

Earlier studies demonstrated that other important variables to explain tax revenues of municipalities are inter alia the tax multiplier, economic output, unemployment rate, population, and employment structure (Buettner, 2003; Bénassy-Quéré et al., 2007; Hasset and Brill, 2007). Further control variables thus aim to capture these influencing factors.

*Other control variables*

Municipal data (economic and socio-demographic variables) for the period 2009-2013 were extracted from the Genesis database for Bavaria for 2054 of the 2056 municipalities (no data for Schöllkrippen and Himmelkron). It includes the following variables: the business tax revenues, the municipal business tax multiplier, population, population density, the debt level per capita, the number of unemployed persons per capita[7], share of the employees in the manufacturing industry, and taxable turnover from products and services. We normalized all monetary values using the consumer price index with the base year 2010.

Due to the right of municipalities to set their own tax multiplier, the tax multiplier has a direct impact on the amount of the business tax revenues, respectively. It between 230 and 490 percentage points. This variable determines the financial burden businesses have to bear depending on the municipality, in which they are located. The impact of the multiplier on tax revenue may be negative or positive, following a Laffer curve similar course[8]. There is also a reverse causality between tax revenue and tax multiplier. This means that if business tax revenues are too low, a jurisdiction could increase the tax multiplier in order to increase business tax revenues. We follow Bénassy-Quéré et al. (2007) as well as

[7] The unemployment rate is not applicable at municipal level in Bavaria – therefore we apply the unemployed persons per capita.
[8] The higher the tax multiplier, the larger the business tax revenues, but at a certain point the multiplier could be too high and thus business tax revenues start to decrease.

Hasset and Brill (2007) and apply lagged values for the business tax multiplier to address this simultaneity problem. In our main estimation, we use a lag of one year, which is replaced by a longer lag of five years in the robustness checks.

We assume that municipalities that are less in debt are more attractive for companies[9]. Therefore, debt level per capita should have a negative impact on the business tax revenues. Unemployment per capita is an indicator to control for temporary shocks to the local economy. The more unemployed people reside in a municipality, the lower may the business tax revenues be because of an assumed lower amount of firms. To control for the economic structure, the share of employees in the manufacturing industry is among other variables included. As a control for the size of the local economy, taxable turnover from sales of products and services is included in the regression. It is a proxy for the economic output and should have a positive impact on the business tax revenue. Population density controls for further differences between the municipalities. There is a strong variation of population from below 250 residents up to almost 1.5 million. There are very densely populated cities and rural areas with almost no land demanding industry.

In addition, at more aggregate, county level, the INKAR database provides data such as the gross domestic product (GDP), a share of small and big companies as a proportion of all companies and the gross value added (GVA) by sector. The economic sectors are industry (production industry), private services (financial industry), public services (public and social services, education and health) and trade (trade, hospitality sector, information and communication). Those variables are used as additional controls because they represent further proxies for the economic output or economic structure at county level.

[9] Municipalities less in debt mostly have a bigger financial leeway and provide a higher level of spending (Buettner, 2001).

**Table 1.** Summary statistics

| | Obs. in the cross section | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| ***Dependent variable*** | | | | | |
| Business tax revenue, in million euro | 2,054 | 0.97 | 17.19 | -29.15 | 744.78 |
| ***Control variables at municipal level*** | | | | | |
| Built-up industrial and commercial (BIC) area, in $km^2$ | 1,695 | 0.48 | 0.1 | -0.33 | 0.86 |
| Business tax multiplier, in % | 2,054 | 7.89 | 18.64 | -50 | 85 |
| Share of employees in the manufacturing industry, in % | 1,982 | -0.01 | 0.07 | -0.6 | 0.37 |
| Taxable turnover from products and services, in million euro | 2,025 | 38.31 | 433.27 | -5,579.48 | 14,696 |
| Debt level per capita, in Thsd. Euro | 1,757 | -0.002 | 0.36 | -2.77 | 2.69 |
| Population, in Thsd. | 2,054 | 45.62 | 1,773.85 | -8,497 | 77,396 |
| Population density, per $km^2$ | 2,054 | 0.47 | 12.92 | -104.29 | 249.02 |
| Unemployed per capita | 2,054 | -0.004 | 0.004 | -0.03 | 0.02 |
| ***Additional control variables at county level*** | | | | | |
| Gross domestic product (GDP) per capita, in Thsd. Euro | 96 | 4.6 | 2.08 | 0.6 | 55 |
| Share of small companies (≤ 10 employees), as proportion of all companies in ‰ | 96 | -6.72 | 3.28 | -18.6 | 3.3 |
| Share of big companies (>250 employees), as proportion of all companies in ‰ | 96 | 0.28 | 0.35 | -1.2 | 1.4 |
| Gross value added: Industry, in % | 96 | 0.02 | 0.03 | -0.05 | 0.14 |
| Gross value added: Private services, in % | 96 | -0.02 | 0.02 | -0.1 | 0.07 |
| Gross value added: Public services, in % | 96 | -0.009 | 0.02 | -0.07 | 0.3 |
| Gross value added: Trade, in % | 96 | -0.004 | 0.02 | -0.06 | 0.09 |
| ***Instrument*** | | | | | |
| Agricultural area and major parts of urban open space area 1995, in $km^2$ | 2054 | 18.38 | 13.52 | 0.49 | 98.05 |

Notes*:* The table shows mean, standard deviation, min and max of changes between observations 2009-2013 by municipality. Monetary values in euro, prices of 2010.

As can be seen from Table 1 – the summary statistics of the variables – there is mostly a large variation in the variables.[10]

[10] Because the municipality Munich is an extreme outlier regarding large business tax revenues per capita (1,247.5 Euro), BIC area (26.5 $km^2$) and other controls, it is excluded from the estimations. This will be examined again in the robustness section.

## EMPIRICAL METHOD AND IDENTIFICATION CHALLENGES

*Ordinary Least Square (OLS) estimation*

To investigate the role of the BIC area and other relevant covariates in explaining the business tax revenue, we first estimate an OLS regression on the differenced cross-sectional data. This means, we examine purely cross-sectional relationships using "between-effects" OLS regressions:

$$\Delta y_i = \beta_0 + \beta_1 \, \Delta BIC\_area_i + \sum \gamma_i \, \Delta X_i + \epsilon_i \qquad (1)$$

where $y_i$ indicates the dependent variable, i.e. the business tax revenues in municipality $i$. The variable $BIC\_area_i$ represents the BIC area in municipality $i$. $X_i$ is a vector of other control variables in municipality $i$ such as the tax multiplier, the debt level, the taxable turnover from products and services, etc. Also variables on county level are included in the regressions. All variables are measured as five-year difference between years 2013 and 2009. $\beta_0$, $\beta_1$, $\gamma_i$ are the coefficients to be estimated. Robust standard errors are applied in all estimations.

*Endogeneity and Instrumental Variables (IVs)*

There is a potential problem in assuming the exogeneity of the BIC area in the OLS regression. As shown above, the business tax is the most important municipal revenue component. Planning, development and land use decisions can be influenced by the financial status of a municipality and hence also by its business tax revenues (cf. Song and Zenou, 2006). For instance, the tax revenue situation of the municipality may affect the provision of the local public goods and thus influence the demand for land in the municipality.

Several studies in the land use literature consider this simultaneity between tax revenues and land use. For example, Song and Zenou (2006) estimate the effect of the property tax rate on urban sprawl. They address the endogeneity issue by employing an instrumental variable approach and make use of state aid to schools as an instrument for the endogenous property tax variable. Brückner and Fansler (1983), McGrath (2005) and Geshkov and DeSalvo (2012) mention the presence of reverse causality but do not address potential biases in their estimations. Geshkov and DeSalvo (2012) suggest interpreting the results where endogeneity is not corrected as partial correlations that indicate empirical regularities.[11]

However, if endogeneity due to simultaneity exists, OLS estimation is biased and cannot be interpreted causally. To address this issue we employ an instrumental variables (IV) regression using two-stage least squares (2SLS). A valid instrument should be highly correlated with the endogenous regressor but uncorrelated with the error term.

To isolate the effect of the BIC area on the business tax revenues, we need an instrument, which is not related with the business tax revenues, but predicts the changes of the BIC area. Our identification strategy is based on using the open space area in the municipality in the year 1995 as an instrument for the BIC area change between 2009 and 2013. More precisely, the measure for the open space that we use includes the agricultural area as well as major parts of urban open space such as parks, urban gardens, recreational and sports areas. The area of forests, mountains and water surfaces is not included into this measure.

Open space area in 1995 is an indicator for the maximum possible amount of land consumption for industrial and commercial purposes within the municipal boundaries. Over the course of time, open space is developed and sealed. The assumption we make by choosing open space area as an instrument is that the more open space a municipality had in 1995, the more area could be built-up for industrial and commercial purposes later on. We thus expect a positive association between the instrument and the BIC area change. The first stage of the 2SLS regression will examine this fact.

We claim that the instrument is uncorrelated with the error term. There is no direct effect of the municipal open space in 1995 on the business tax revenues in 2009-2013, which is not running through the endogenous regressor (change in the BIC area).[12] We address the potential effects running through

[11] In the land use literature, a number of papers studied the reverse effect chain. They examined the effect of tax rates or tax revenues and other control variables on the size of urbanized areas, urban sprawl or land consumption. A significant and negative effect of the property tax rates on the size of the urbanized area was found (Song and Zenou, 2006; Wassmer, 2008; Geshkov and De Salvo, 2012). On the other hand, also a significant and positive effect of tax revenues (including business tax) on land consumption was found (Siedentop et al., 2009).

[12] To support this argument, we performed an OLS estimation in which we regressed the dependent variable (business tax revenues) on the endogenous regressor, the instrumental variable and further control variables (available upon request). To meet the exclusion restrictions of a strictly exogenous instrument, the coefficient in

omitted variables by a well-considered set of control variables. Furthermore, we rule out any reverse effect of the dependent variable on the instrument due to a large time lag between them. The exogeneity of the instrument can in general not be tested. Nevertheless, in summary, we can rule out any direct effect of our instrument on the dependent variable and vice versa (exclusion restriction). Furthermore, we test alternative definitions for the instrument, including the areas of forests, mountains and water surfaces, which however does not affect the results significantly.

In the first stage, the change in the industrial and commercial area is decomposed into a component explained by the instrument and a problematic component $v_i$. The first stage is specified as follows:

$$\Delta BIC\_area_i = \alpha_0 + \alpha_1 OS_i + \sum \mu_i \, \Delta X_i + v_i, \quad \text{where} \qquad (2)$$

$\Delta BIC\_area_i$ = change of BIC area between 2009 and 2013 in the municipality $i$;

$OS_i$= open space area as of 1995 in the municipality $i$;

$X$ = Vector of other explanatory variables.

In the second stage, the fitted values of $\Delta \widehat{BIC\ area}$ from the first stage are used instead of the problematic (endogenous) value of $\Delta BIC\ area$ in equation (1). The second stage is specified as follows:

$$\Delta y_i = \beta_0 + \beta_1 \Delta \widehat{BIC\_area}_i + \sum \gamma_i \, \Delta X_i + \epsilon_i, \quad \text{where} \qquad (3)$$

$y_i$= dependent variable of interest, i.e. business tax revenues of municipality $i$.

To be valid, the instrument must also be relevant (correlated with the endogenous regressor). To get an indication of the relevance of the instrument, the first stage Kleibergen-Paap F statistic is considered. To test whether the effect of the instrument is significantly different from zero, as a rule of thumb, this F-statistic must be larger than 10.

In the econometric estimations, we do two things to make sure that our findings are not biased by bad controls. First, we estimate a parsimonious model that regresses the business tax revenues on the BIC area, without further controls. Further control variables – at municipal and county level - are added in

front of the instrumental variable should be statistically zero (Wooldridge, 2002). The estimation indicated that there is no direct effect of the instrumental variable on our dependent variable.

subsequent estimations. Second, we present a variety of different specifications and robustness checks in a separate section[13].

# RESULTS

*Main specifications*

Table 2 presents the cross-sectional OLS (columns 1 and 2) and IV (columns 3, 4 and 5) estimation results. In the OLS case, the coefficient of the BIC area decreases from about 20.8 €/$m^2$ in the parsimonious model to 12.7 €/$m^2$ in the model that includes further control variables. As discussed above, the OLS results are likely to be biased and should therefore be considered with caution.

Therefore, we now turn to the IV estimations. As the significance of the corresponding coefficients from the first stage regressions indicate, our instrument is a strong predictor for the BIC area change. As expected, the coefficient is positive. In addition, the Kleibergen-Paap Wald F-statistic is reported in the last row of Table 2 as a test of the strength of our instrument. The F-statistic values above 10 indicate that the instrument is strong and relevant. This implies, for a single instrument and one endogenous regressor, the t-value for the instrument should be bigger than 3.2 to confirm the instrument's relevance, which is met in all first-stage estimations as indicated (Staiger and Stock, 1997).

[13] We also tried to employ the panel structure of our data and conducted fixed effects (year and municipality) regressions with the full dataset (2009-2013). Endogeneity issues could however not be addressed in this setting, due to the lack of a suitable time-varying instrument. Nevertheless, the results from the panel data regressions are close to the results found in the cross-sectional IV regressions and are available from the authors upon request.

**Table 2.** Effects of the BIC area on the business tax revenues.

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| | OLS | OLS | IV | IV | IV |
| Built-up industrial and commercial area | **20.81***** | **12.73**** | **20.52***** | **16.9***** | **12.85***** |
| | **(7.56)** | **(5.49)** | **(7.84)** | **(4.97)** | **(3.57)** |
| Control variables at municipal level | NO | | NO | | |
| *Business tax multiplier (one year lagged)* | | **0.015**** | | 0.006 | **0.015**** |
| | | **(0.007)** | | (0.004) | **(0.007)** |
| *Debt level per capita* | | **-0.758*** | | **-1.07**** | **-0.757*** |
| | | **(0.367)** | | **(0.451)** | **(0.395)** |
| *Population density* | | 0.028 | | 0.03 | 0.028 |
| | | (0.034) | | (0.037) | (0.035) |
| *Unemployed per capita* | | -27.13 | | -38.15 | -26.78 |
| | | (35.37) | | (44.24) | (40.39) |
| *Share of employees in the manufact. industry* | | 0.818 | | 0.019 | 0.82 |
| | | (0.871) | | (0.83) | (0.881) |
| *Taxable turnover from products and services* | | **0.005*** | | **0.007*** | **0.005*** |
| | | **(0.003)** | | **(0.004)** | **(0.003)** |
| Further controls at county level | NO | | NO | NO | |
| *% GVA Industry* | | -13.09 | | | -13.09 |
| | | (8.37) | | | (8.35) |
| *% GVA Public services* | | 12.97 | | | 12.92 |
| | | (9.55) | | | (9.74) |
| *% GVA Private services* | | -0.85 | | | -0.87 |
| | | (6.75) | | | (6.9) |
| *GDP per capita* | | **0.828**** | | | **0.827**** |
| | | **(0.397)** | | | **(0.394)** |
| *Share of big companies* | | -0.057 | | | -0.056 |
| | | (0.447) | | | (0.436) |
| N | 1694 | 1383 | 1694 | 1383 | 1383 |
| F test | 7.58 | 1.90 | 6.84 | 2.8 | 2.53 |
| $R^2$ | 0.1362 | 0.3792 | 0.1492 | 0.2997 | 0.3893 |
| **First-stage results:** | | | | | |
| Open space 1995 | | | **0.003***** | **0.003***** | **0.003***** |
| | | | **(0.0003)** | **(0.0003)** | **(0.0003)** |
| t-value | | | 10.34 | 9.36 | 9.20 |
| **First-stage diagnostic** | | | | | |
| Kleibergen-Paap F statistic | | | 106.99 | 87.61 | 84.70 |

Note: Dependent variable is the business tax revenue change. All variables are measured as differences between 2013 and 2009 values. Robust standard errors are in parentheses: * p<0.1, ** p<0.05, *** p<0.01. 2SLS regressions—variables excluded from second stage: open space area 1995.

In the parsimonious formulation, the coefficients for the BIC area change - the variable of primary interest - differ only slightly between the OLS (column 1) and IV (column 3) estimations and are in the order of 21 €/m². This coefficient decreases to about 17 €/m² in the IV estimation when the control variables at municipal level are added (column 4). In the full model (column 5), the coefficient of the BIC area again decreases to almost 13 €/m$^2$ in the second stage IV estimation. Accordingly, each one hectare increase in the industrial and business area implies an almost 13,000 euro increase in the business tax revenues of a municipality. We will compare this value with the costs of first-time land development in the discussion section. Compared to the OLS estimation, the coefficient of the full IV model is only 0.1 €/m$^2$ larger, which could be interpreted as a slight downward bias on the side of the OLS estimates.

The signs of statistically significant coefficients conform to our predictions. The business tax multiplier and the taxable turnover from products and services have positive and significant coefficients. The business tax revenue is an increasing function of the business tax multiplier at this point of the Laffer curve. The debt level coefficient is negative and significant, also as expected. At county level only the GDP per capita has a positive and significant coefficient.

*Urban-rural differentials*

In Table 2, we report the mean effect of the BIC area on the business tax revenues including a set of relevant controls. An additional question of interest concerns the differences between area types. In this subsection, we therefore aim to look in detail at the differences in this effect between more and less densely populated, rural and urban municipalities. We will isolate the effect of BIC area increase on tax revenues in certain types of municipalities by adding different interaction terms to the IV regression specified in column (5) of Table 2.

The first set of interaction terms is formed by multiplying the change in the BIC area by a dummy variable equal to 1 if the municipality belongs to a certain top quantile with respect to population density. We construct such dummy variables for the top 75%, 50%, 25%, 10% and 5% of most densely populated municipalities. We run a separate regression for each of these five cases. In addition, two more regressions are estimated, which use the BBSR area types[14] for creating the interaction terms. In these

[14] The BBSR area types are taken from: http://www.bbsr.bund.de/BBSR/DE/Raumbeobachtung/Raumabgrenzungen/Raumtypen2010_vbg/Raumtypen2010_alt.html?nn=443270.

cases, the dummy variable is equal to 1 if the municipality is classified as at least partially urban or as mostly urban.

The results are presented in Table 3. Two coefficients are reported in every column. The coefficient for the variable “BIC area change” alone shows the effect of land consumption on tax revenues in the municipalities not belonging to the respective top quantile. The sum of the two coefficients then shows the effect for the municipalities in the top quantile.

In Table 3, there is always a significant difference between more and less densely populated areas. Moreover, the size of the effect increases for higher density quantiles. The results thus suggest that the business tax revenues from BIC area change are larger the more densely populated the municipalities are. However, this effect seems to be driven by the few most densely populated municipalities, which are the major cities in Bavaria. The difference between these cities and the rural areas can be visualized by comparing the estimate of 7 €/$m^2$ for the 25% of least densely populated municipalities (column 1) to almost 54 €/$m^2$ for the top 5% (column 6).

The same tendency is found when we differentiate the municipalities according to the BBSR area types. Column (7) and (8) indicate that mostly urban areas receive more tax revenues per $m^2$ of the BIC area than areas that are less urbanized.

**Table 3.** IV estimations including interaction terms

| | (1) | (2) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|
| Interaction dummy | Top 75 % | Top 50 % | Top 25 % | Top 10 % | Top 5% | Partially or mostly urban | Mostly urban |
| BIC area change | **7.01*** (3.82)** | **6.16** (2.8)** | **6.69** (2.63)** | **7.27*** (2.24)** | **6.83*** (2.18)** | **5.01** (2.48)** | **7.14*** (2.43)** |
| BIC area change x Interaction dummy | **7.25*** (3.44)** | **13.18*** (3.9)** | **22.16*** (6.32)** | **42.62*** (10.97)** | **53.29*** (13.28)** | **19.71*** (5.07)** | **34.61*** (9.02)** |
| Control variables | YES | YES | YES | YES | YES | YES | YES |
| N | 1383 | 1383 | 1383 | 1383 | 1383 | 1383 | 1383 |
| F | 2.64 | 2.64 | 2.65 | 3.64 | 4.52 | 2.80 | 2.94 |
| $R^2$ | 0.3965 | 0.4155 | 0.4518 | 0.5589 | 0.6172 | 0.4350 | 0.4857 |
| *First-stage diagnostic* | | | | | | | |
| Kleibergen-Paap F statistic | 45.59 | 49.08 | 51.66 | 47.67 | 50.94 | 39.88 | 50.93 |

Note: Dependent variable is the business tax revenue change. Robust standard errors are in parentheses: * p<0.1, ** p<0.05, *** p<0.01. 2SLS regressions - variables excluded from second stage: open space area 1995.

## ROBUSTNESS CHECKS

In this section we perform a number of robustness checks to explore whether the key results are stable. In doing so, we concentrate on the main coefficient of interest, the effect of BIC area change on the change in municipal business tax revenues. We build on the cross-sectional IV specification including all available control variables at municipal as well as county level.

First, we change the time span of the cross-sectional difference IV regression to the period 2009-2012 and 2010-2013. This is a check on whether the estimated coefficients mainly depend on the years analyzed or whether general, consistent statements can be derived. As can be seen from Table 4 (columns 1 and 2), the effects are roughly 10 and 21 €/$m^2$, respectively, and statistically significant. Our main estimate of almost 13 €/$m^2$ from Table 2 lies between these two estimates and the deviations from this point estimate are not statistically significant, as suggested by the Wald tests.

**Table 4.** Robustness checks.

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | 2009-2012 | 2010-2013 | 5 year lag of the tax multiplier | Business tax revenue above zero | Extreme residuals excluded | Cities with county status excluded |
| Built-up industrial and commercial area | **21.09*** (5.58)** | **10.29** (4.03)** | **12.54*** (3.56)** | **14.42*** (4.32)** | **7.16*** (1.70)** | **6.84*** (1.69)** |
| Wald test (p-value) $H_0$= coefficient not signif. different from 12.85 (coefficient main specification) | 0.1403 | 0.5263 | 0.9326 | 0.7157 | 0.0008 | 0.0004 |
| Control variables | YES | YES | YES | YES | YES | YES |
| N | 1472 | 1339 | 1383 | 1044 | 1373 | 1363 |
| F | 2.33 | 2.44 | 2.71 | 2.78 | 8.22 | 3.22 |
| $R^2$ | 0.2729 | 0.5254 | 0.3867 | 0.4915 | 0.3202 | 0.09 |
| **First-stage IV results:** | | | | | | |
| Open space 1995 | **0.002*** (0.0002)** | **0.002*** (0.0002)** | **0.003*** (0.0003)** | **0.003*** (0.0004)** | **0.003*** (0.0003)** | **0.002*** (0.0003)** |
| t-value | 8.64 | 8.21 | 9.21 | 7.63 | 8.98 | 8.63 |
| *First-stage diagnostic* | | | | | | |
| Kleibergen-Paap F statistic | 74.66 | 67.39 | 84.90 | 58.22 | 80.65 | 74.49 |

Note: Dependent variable is the business tax revenue change. Robust standard errors are in parentheses: * p<0.1, ** p<0.05, *** p<0.01. 2SLS regressions - variables excluded from second stage: open space area 1995.

In the second robustness check, we use a five-year lag instead of the one-year lag of the change in the business tax multiplier (2004-2008 instead of 2008-2012). As discussed above, there is a reverse causality between the tax revenue and the tax multiplier. In the main estimation we followed Bénassy-Quéré et al. (2007) as well as Hasset and Brill (2007) and applied one year lagged values for the business tax multiplier. The longer time lag is supposed to reduce the endogeneity concerns. The results in column (3) show that the new estimate is not significantly different from the main estimate.

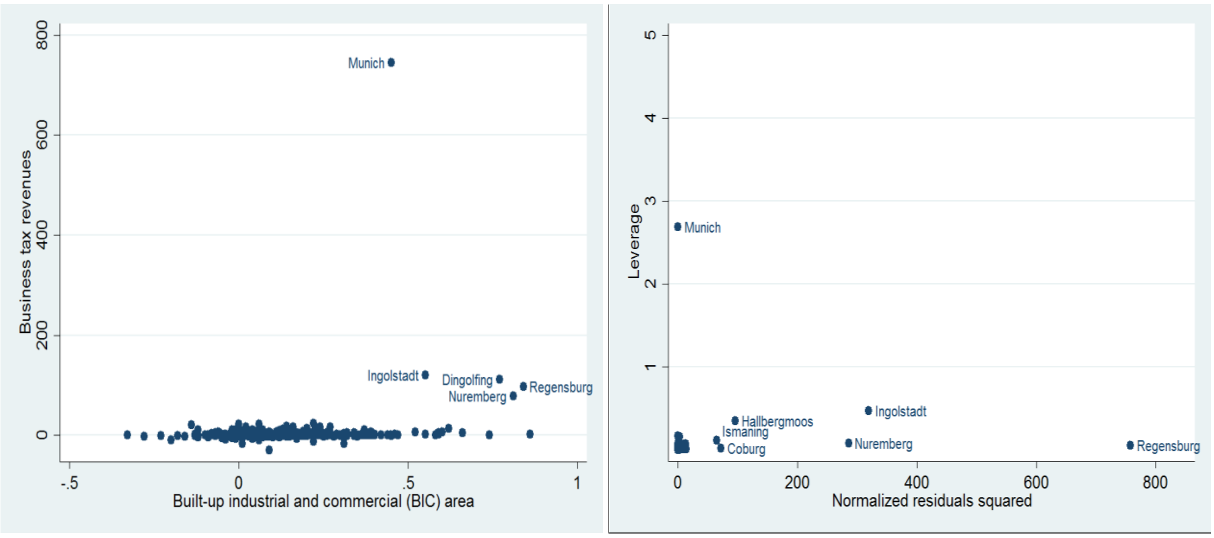
Next, we exclude those municipalities that in 2013 received less business tax revenues compared to 2009. Thereby we check whether the main results are influenced (biased downward) by the municipalities with a negative tax revenue development. As can be seen from column (4), the coefficient is only slightly (not significantly) larger compared to the main specification.

As a further robustness check, we exclude from the estimations municipalities whose studentized residuals stick out from the other municipalities. We also look at the leverage's to identify observations that have great influence on regression coefficients. In this way, we check whether the main results could be outlier-driven.

Figure 2 (left panel) plots the business tax revenues against the BIC area for all municipalities, including Munich. This scatter plot suggests that the observation for Munich stands out from all other points. The exclusion of Munich in previous estimations was thus legit. However, other municipalities could potentially be unusual or influential, as well.

Therefore, we examine the residuals from the full IV regression (Table 2, column 5).**Fehler! Verweisquelle konnte nicht gefunden werden.** In Figure 2 (right panel) we present the leverages (deviation of the dependent variable from its mean) plotted against the squared normalized residuals to identify observations that will potentially have big influence on the estimates. From this analysis, again some of the cities with county status – e.g. Nuremberg, Regensburg, Ismaning, Coburg, Hallbergmoos and Ingolstadt – stand out due to their large leverage or large residuals squared.

**Figure 2.** Outlier and leverage analysis




In column (5) of Table 4 we exclude those municipalities that based on the analysis above have potential large influence on the regression coefficient estimates. These are in particular the municipalities of Nuremberg, Regensburg, Ingolstadt, Coburg, Ismaning, Hallbergmoos. In a final check (column 6), we exclude all cities with county status.

As can be seen from columns (5) and (6), the BIC area coefficient drops to 7.16 and 6.84, respectively, and these estimates are significantly different from the main estimate from Table 2. This finding again can be regarded as an indicator for the large heterogeneity among the municipalities in terms of the tax revenue effects from BIC area change. Especially cities with county status receive more business tax revenues. The $R^2$ as a measure of fit also decreases strongly, which indicates that the main results are largely driven by these excluded municipalities (main cities).

## DISCUSSION: LAND DEVELOPMENT COSTS AND DEVELOPMENT PERMITS

How large are the identified tax revenue effects of BIC area change? Although it is not possible to draw specific conclusions about the profitability of land development for different municipalities from the available data, we can try to compare our estimates to the indicative figures on the costs of land development.[15] Reidenbach et al. (2007) and Köller and Henger (2010) report that the costs of initial land development for industrial and commercial purposes in Germany are in the range of 15-35 €/$m^2$. This range includes internal as well as external land development costs[16], planning costs, compensation costs and partly social costs (e.g. social infrastructure such as kindergartens and schools). This does not include the potential costs of land purchase from private owners as well as potential negative effects on general purpose and need-based transfers and can thus be regarded as a minimum range. Additionally, annual operating expenses for the developed area are in the range of of 3-4 €/$m^2$ (Reidenbach et al., 2007) which is also considered a minimum.

Given these figures, one can seriously doubt that land development efforts, especially in rural municipalities, will usually bring enough tax returns to cover the development and maintenance costs. They rather confirm the relevance of the warning about ruinous competition between the municipalities as articulated by Mönnich (2005) or Sbosny and Siebert (2010). For economically strong urban areas,

[15] Cost and community service studies aim to provide a complete picture of revenues and expenditures for selected case study regions. They evaluate the fiscal situation of land consumption projects considering available information and data (Dorfman, 2006; Leighton and Meyer, 1999). Assessing real costs for planning and land development is very challenging. The provision of building land for industrial and commercial purposes differs widely regionally and depending on the economic sector of the settling businesses.

[16] The costs involve construction measures such as the connection to public road network as well as supply and disposal which can be on-site (internal) or off-site (external) of the building area. In this example the municipalities bear only 10 % of costs for internal land development and 100 % for external land development.

the fiscal balance of land development is better, which also provides background to the discussion on the tradable planning permits as an economic instrument to effectively and transparently control land consumption (Bovet, 2006; Schweppe-Kraft et al., 2008; Henger and Thomä, 2009; Henger and Bizer, 2009; Henger, 2013).

Given the large differences in the tax effects of BIC area change between areas identified in this study, such a mechanism seems a reasonable tool to limit the potentially unprofitable land development in the rural municipalities.

Additionally, the integration of obligatory tests (integrated impact analysis) that measure ecological impacts and determine economic effects of land development projects and their advantages for municipalities could be considered (Schweppe-Kraft et al., 2008). Another option would be to support cooperation networks of neighboring authorities on the development of commercial areas - sharing of costs and revenues (European Commission, 2012).

## CONCLUSIONS

The aim of this paper was to empirically study and quantify the effect of BIC area change on municipal business tax revenues. Based on a dataset for Bavaria covering years 2009-2013, we find an average effect of about 13 € per $m^2$ of BIC area increase. The significant and positive effect is confirmed in the robustness checks. However, the size of the coefficient seems to be driven by the main cities and reduces when these are dropped from the sample. Additional analyses involving interaction dummies for different area types support these findings. There exist strong differences in the tax effects of land consumption between urban and rural municipalities.

Land consumption in cities and municipal agglomerations thus generates more business tax revenues than in rural areas. In terms of policy implications, this suggests that a scheme involving tradable development permits would have a redistributive effect – profits from land consumption will be partly redirected from urban and densely populated municipalities to areas that are less populous. The urban municipalities would buy planning permits from rural areas once their contingents are exhausted and as long as it is profitable to do so. The rural areas would then have an alternative source of revenue and will not be bound to increase land consumption in the hope to attract investors.

Furthermore, the comparison with the costs of first time land development suggests that the rural municipalities might see their land development projects not bring the expected profits. This confirms the hypothesis about the "ruinous competition" between the rural municipalities.

Nevertheless, our results need to be interpreted with caution. Even though we took much care in trying to prove the robustness of our results, the heterogeneity of the Bavarian municipalities makes it difficult to derive general statements. In addition, due to the attributes of the land use data, we are only able to assess the tax revenue effect of the realized land consumption, and not of the initial efforts of the municipalities to develop land.

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