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# Does Highway Accessibility Influence Local Tax Factors? Evidence from German Municipalities

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## Does Highway Accessibility Influence Local Tax Factors? Evidence from German Municipalities

### Abstract

We examine how highway accessibility influences tax policy. We exploit the stagewise expansion of the “Baltic Sea highway” in the East German state Mecklenburg-Western Pomerania as the largest contiguous highway construction project in Germany since 1945. For non-agglomeration municipalities that lie on a convenient route between two larger cities the access and opening year are close to random. Results from difference-in-differences estimations and an event study approach show that highway access influences local tax setting in municipalities within 5 to 10 km road distance. Improved accessibility increases property tax factors persistently by roughly 6 percentage points. Our effects are driven by peripheral municipalities, while we do not find an influence on core municipalities. Additionally, improved accessibility gives rise to a shift of population and economic activity from the periphery to the core.

JEL code: H54, H71, O18

Keywords: Highway, infrastructure, accessibility, tax factors, municipalities, local governments

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# 1 Introduction

New infrastructure projects are often viewed as catalysts for regional economic growth. However, there is an ambiguity of new transportation infrastructure known as the “two way roads problem” (Cheshire *et al.*, 2014). On the one hand, infrastructure acts as an agglomeration force because it improves a region’s access to other regions. This taps additional market potential as (new) markets become accessible at reduced cost (Donaldson, 2018). On the other hand, investment in infrastructure triggers deagglomeration forces. Reachability of a region *from* other regions is broadened, increasing competitive pressure. Against this background, policymakers might react to changing local economic conditions and adapt their tax policies. If, for example, the agglomeration benefits outweigh the deagglomeration force, agglomeration rents can be taxed.

The theoretical prediction of taxable agglomeration rents has been widely established by the new economic geography literature (see e.g., Baldwin and Krugman, 2004; Krugman, 1991). While empirical contributions have shown a reduced sensitivity of firm location to corporate taxes in the presence of agglomeration economies (Brühlhart *et al.*, 2012; Devereux *et al.*, 2007; Jofre-Monseny and Solé-Ollé, 2012), more direct assessments of whether local policymakers tax agglomeration rents are relatively scarce. Notable exceptions include Charlot and Paty (2007) and Koh *et al.* (2013), who both find that agglomeration effects increase local tax rates. Similar to Charlot and Paty (2007), we argue that market access is the main agglomerating force that affects local taxation. We consider business and property tax factors<sup>1</sup> that are set by local policymakers. To test the relationship between tax factors and market access empirically, we exploit a particularly fast and extensive expansion of the East German highway network in the aftermath of reunification. As a proxy for municipalities’ market access, we use road-distance measures to the next highway access point.

Many studies examine how infrastructure development affects economic outcomes. Large infrastructure investments in developing countries such as China or India offer a widely-used testing ground for these questions. Evidence on the general positive effect of transportation infrastructure on regional<sup>2</sup> economic development (Ahlfeldt and Feddersen, 2018; Banerjee *et al.*, 2012; Donaldson and Hornbeck, 2016; Hornung, 2015), however, has been complemented by findings that confirm substantial heterogeneity at the local level (Berger and Enflo, 2017; Chandra and Thompson, 2000; Faber, 2014). In China, better regional highways increase production and population in “regional primates” at the expense of peripheral areas (Baum-Snow *et al.*, 2018). Highways have also distributional

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<sup>1</sup>The actual business and property tax rates are determined by multiplying the tax factor with a uniform base rate.

<sup>2</sup>At the firm level, there exists evidence that new transportation infrastructure influences production optimization (Datta, 2012) as well as, ultimately, productivity (Gibbons *et al.*, 2019; Holl, 2016; Wan and Zhang, 2018).

consequences. For Switzerland, Fretz *et al.* (2017) show that in non-urban municipalities, the advent of a highway access point within 10 km increases the share of top-income taxpayers.

Our empirical study relates to the new economic geography literature predicting taxable agglomeration rents and the literature evaluating the effects of new transportation infrastructure. Contrary to previous contributions to infrastructure evaluation, we investigate how infrastructure development influences economic policies rather than economic outcomes. In a new economic geography framework, infrastructure development, i.e., a reduction in trade costs, might create taxable rents due to agglomeration economies. When examining possible channels that drive the tax policy effect, we test for variables that have been shown to react to new transportation infrastructure, e.g., employment (Duranton and Turner, 2012; Lin, 2017; Möller and Zierer, 2018), population (Ángel García-López *et al.*, 2015; Baum-Snow, 2007), commuting flows (Baum-Snow, 2010; Heuermann and Schmieder, 2018) and house prices (Mikelbank, 2004).

Our sample covers the period 1995-2015 in the German state of Mecklenburg-Western Pomerania (MV). More specifically, we consider the opening of the highway number 20 (BAB 20 or “Baltic Sea highway”) in MV, which constitutes an ideal setting for two reasons. First, the opening of the BAB 20 in MV took place in several stages, providing us with variation in the timing of infrastructure access. Second, as the largest contiguous highway construction project since 1945 in Germany, the BAB 20 had a considerable impact on municipalities’ accessibility. During our sample period a municipality’s average distance to the next highway access was more than halved. The location of new highways is likely endogenous to regional fundamentals because highways are built to connect economic units. To reduce concerns of endogeneity, we follow the inconsequential units approach and exclude large and economically strong cities that shape the route of the highway (Banerjee *et al.*, 2012; Chandra and Thompson, 2000; Faber, 2014; Möller and Zierer, 2018). Non-agglomeration regions often receive access to a new highway because they are located on a convenient route between two larger cities that are connected. The exact opening year for these municipalities is close to random. Using difference-in-differences and event study estimations, we find that municipalities located within a road distance of 5-10 km to the next highway access increase their property tax factors. This effect is driven by peripheral or very peripheral municipalities that, due to the spatial structure of MV, make up the majority of our sample. In any event, when examining possible channels, we provide some suggestive evidence of counteracting effects between central and peripheral municipalities. It seems that central localities benefit from highway accessibility in terms of population and employment effects, but do so at the expense of the periphery.

## 2 Theoretical considerations and hypothesis

The new economic geography literature shows that improved accessibility can have ambiguous effects on tax policies (Fujita *et al.*, 2001; Krugman, 1991). New infrastructure acts both as an agglomeration force or a deagglomeration force (the “two way roads problem”, Cheshire *et al.* 2014).

Improved access *to* other regions taps new market potential as transportation costs to (new) markets decline. This in turn might attract new business activity and new residents (market potential or agglomeration effect). In contrast, being more easily and cheaply accessible *from* other regions might increase competitive pressure. High transportation costs are equivalent to tariffs and protect local producers. As transportation costs decline, inter-regional competition increases. When it becomes more profitable for consumers to import products rather than purchase from local producers, the connected region could lose economic activity (competition or deagglomeration effect). Whether the market potential or the competition effect prevails could depend on the location of a region. Following the core-periphery model by Krugman (1991), peripheral producers are protected by high transportation costs. As transport costs decline, the periphery is delivered from the core at a reduced rate, while core producers exploit agglomeration benefits. Baum-Snow *et al.* (2018), for instance, show that the construction of the Chinese national highway system increased population and economic output – not overall, but mainly in core regions – at the expense of peripheral regions.

When regions get connected to the highway network, we expect that the competition or deagglomeration effect outweighs the market potential or agglomeration effect in peripheral regions, and vice versa for core regions. If deagglomeration forces dominate, one might expect municipalities to reduce tax factors to stay competitive or to increase tax factors to sustain their tax revenues. If, on the other hand, agglomeration forces should dominate, business and property tax factors might increase as agglomeration rents can be taxed (see Baldwin and Krugman 2004; Kind *et al.* 2000; Krogstrup 2008; Ludema and Wooton 2000 for theoretical studies and Buettner 2001; Charlot and Paty 2007; Luthi and Schmidheiny 2014 for empirical investigations). Thus, it is not clear from a theoretical point of view whether and how increased accessibility affects tax factors. We will assess this question empirically.

## 3 Institutional background

### 3.1 The Federal system of Germany

The federal system of Germany distinguishes between the federal and state level as two layers of government. Local governments with counties (*Landkreise*) and municipalities (*Gemeinden*) are part of the state level. The German Constitution guarantees municipalities the right of self-government (Art. 28 Basic Law). Responsibilities regarding their expenditures involve transferred compulsory tasks that are assigned by the federal government (*übertragene Selbstverwaltungsaufgaben*), compulsory responsibilities (*pflichtige Selbstverwaltungsaufgaben*) and voluntary self-government responsibilities (*freiwillige Selbstverwaltungsaufgaben*). For voluntary tasks, municipalities possess full autonomy of decision. They decide on whether they will engage in these tasks and determine how much they want to invest or what quality they want to provide. The voluntary responsibilities of municipalities comprise economic, cultural, and social issues like public transport, industry settlements, libraries, theater, sport facilities, and elderly care. Compulsory tasks, like energy and water supply or land-use planning must be executed by the municipalities, but they decide on how to do so. This is different for transferred compulsory responsibilities (for instance public administration and building supervision), where municipalities have no discretionary power at all.

Municipalities also have revenue autonomy by setting user charges and taxes. Within the scope of their self-government responsibilities, they determine tax factors for business tax (*Gewerbesteuer*), general property tax (*Grundsteuer B*) and agricultural property tax (*Grundsteuer A*) independently.<sup>3</sup> The tax liability then results from multiplying the tax factor with a tax assessment base. For property tax, this assessment base is in turn determined by the rateable value of real estate (*Einheitswert*), which was last assessed in 1935 for East Germany and in 1964 for West Germany.<sup>4</sup> The assessment base for the business tax is the companies' profits. Along with the income and value-added tax, business and general property taxes are important sources of municipal revenue. In 2015, the business tax and income tax<sup>5</sup> amounted to 38% and 37% of municipality tax revenue in the German state of Mecklenburg-Western Pomerania. The general property tax had a share of 16%. The property tax for agriculture is rather unimportant and contributed merely 1.5% of all tax revenues.

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<sup>3</sup>In the GDR, the business tax was not a municipal tax: it was a federal tax with a uniform tax factor of 400%. The property tax was a municipal tax in the sense that its revenues accrued to the municipalities only, but tax factors for both types, general and agricultural property tax, were uniform across the GDR (Duda, 2010).

<sup>4</sup>Adherence to this outdated reference point actually led to the Constitutional Court ruling in April 2018 that these provisions violated the general principle of equality.

<sup>5</sup>Municipalities cannot change the tax factors for income tax.



### 3.2 Highway expansion in Mecklenburg-Western Pomerania

After reunification, as part of the German Unity Transport Project (*Verkehrsprojekt Deutsche Einheit*), the highway number 20 (*Bundesautobahn 20* – BAB 20) was built through Lower Saxony, Schleswig-Holstein, Mecklenburg-Western Pomerania, and Brandenburg to better connect regions in MV to the Western German and European transportation network. The BAB 20 is the longest contiguous highway construction project in Germany since 1945.

Plans for long-distance roads passing through MV have existed since the 1930's. In construction plans from 1926, two streets connect Lübeck with Stettin<sup>6</sup>, one in the interior of the country running through Neubrandenburg, and one following the coastline passing by Stralsund. In 1934, the west-east connections disappeared in the construction plans and were replaced by north-south routes, connecting Hamburg, Stettin, Rostock, and Stralsund directly with Berlin. This route was given up in 1935 in favor of a new route in eastern direction. After an extensive examination of traffic conditions and requirements in Mecklenburg and Western Pomerania, the precursor of the BAB 20 was incorporated into the network of the *Reichsautobahnen* in 1937. Even though construction started in 1938, it was stopped in 1939 because of WWII. The construction of the BAB 20 was still planned by the German Democratic Republic, but the regional road development in north-eastern Germany was – due to the division of Germany – aligned for decades in a north-south direction (BMVBW et al. 2007).

After reunification, the construction of the BAB 20 started in 1992; in 1997 its first 26 km were opened for the public in MV. Another 311 km, spread on 18 subsections (16 in MV), opened between 2000 and 2009. The total length of the BAB 20 amounts to 345 km<sup>7</sup>; 280 km are located in MV. Starting in Lübeck in Schleswig-Holstein, the BAB 20 runs in an eastern direction through the cities of Wismar, Rostock, and Greifswald. In Greifswald, the BAB 20 turns south to connect the city of Neubrandenburg, where it turns south-east to the highway intersection of Uckermark in the state of Brandenburg (see figure 1). There the BAB 20 merges with the BAB 11, which leads to Berlin. Parts of the BAB 14 were also open for the public and connect Wismar and Schwerin with Saxony-Anhalt and Saxony in the south of MV.<sup>8</sup> Other highways that run through MV and have already been open in 1992 are the BAB 24, connecting Hamburg and Berlin, the BAB 19, connecting Rostock and Berlin, and a small segment of the BAB 11, connecting the Polish border with Berlin. Figure 1 shows the highway network in MV in the year 1995 (gray) and 2015 (black). Further, it shows the change in municipalities' road distance to the highway network. Darker shaded areas mark those municipalities with the highest distance changes. Distance is measured as the road

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<sup>6</sup>Szczecin, Poland.

<sup>7</sup>196 km in Lower Saxony are still planned

<sup>8</sup>In 2006, BAB 241 was renamed and became part of the BAB 14.

distance (in km) of each municipality’s centroid in MV to the nearest highway access in each year. In 1995, the average road distance between a municipality centroid in MV and the nearest highway access was 53 km. With the expansion of the highway network, the road distance was more than halved; in 2015 the nearest highway access was on average within a distance of 25 km. Especially the north-east of MV with the regional centers Stralsund, Greifswald, and Neubrandenburg gained access to the highway network via the BAB 20.

[Figure 1 about here]

## 4 Empirical analysis

### 4.1 Data and sample

We use a panel of yearly fiscal and geographical data at the municipal level in Mecklenburg-Western Pomerania. As dependent variables and tax policy measures we use tax factors for business and property tax. Due to the small revenue share of the property tax for agriculture, we focus on the general property tax. To calculate the road distance to the closest highway access, we use geographic data from the Federal Office for Cartography and Geodesy and Geofabrik. Using GIS software, OpenStreetMap Data, and the Open Source Routing Machine (OSRM), we compute the distance measure as the road distance in km of a municipality’s centroid to the nearest highway access in each year.

We focus on the time period between 1995 and 2015. After 1995, the length of the road network of national primary, state, and county roads in MV stayed constant, and the only change in the road network was due to the construction of the highway (see table A1 in the appendix).<sup>9</sup> There have been several municipality reforms during this period. We adjust the data to the territorial status of 2015.<sup>10</sup> We exclude the cities Schwerin, Rostock, Wismar, Stralsund, Greifswald, and Neubrandenburg for two reasons. First, they have been consolidated city-counties until 2011 (after 2011, only Schwerin and Rostock remained consolidated city-counties). Consolidated city-counties exercise functions of counties and municipalities at once and are therefore not comparable to municipalities. Second, the highways in MV are mainly built to better connect these cities and we exclude them to reduce endogeneity concerns. Our final panel dataset, after adjusting for municipality

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<sup>9</sup>By starting our panel in 1995, we avoid possible tax-mimicking between East and West German municipalities after reunification. Baskaran (2015) shows that East-German municipalities at the inner-German border mimicked tax rates from West German municipalities after reunification, but only in the first two years and only for the business tax.

<sup>10</sup>Our baseline results are unchanged when we exclude all merged municipalities from our sample; see table A2 in the appendix.

reforms and excluding independent cities, includes 745 municipalities over the period 1995-2015.

We control for lagged demographic and electoral control variables. Demographic variables include population size (in log), population by age groups (age under 15, age between 15 and 25, age between 25 and 40, and age between 40 and 65), and population density. We include four age variables to map the age structure of the population, since the demand for public expenditures may vary over the life cycle (Buettner, 2001). As electoral controls, we use the share of left-wing votes<sup>11</sup> in the last municipal election, as well as those of elections for the county assembly (*Kreistag*), and state assembly (*Landtag*). We include the individual party vote shares to control for potential redistributive motives of left-wing governments (Krause and Potrafke, 2019). In a robustness test, we further include the share of the unemployed.<sup>12</sup> Mecklenburg-Western Pomerania shares an eastern border with Poland. To control for the dynamic economic growth accompanying Poland's transition to a market-based economy during the 1990s, which might have an impact on economic development in Mecklenburg-Western Pomerania, we include in a robustness test GDP in Poland multiplied with the inverse linear distance of each municipality to the Polish border.

Table 1 shows the descriptive statistics. We use data in levels. The business tax factor was on average 292, ranging between 100 and 450. The average property tax factor (316) was slightly higher and varied between 200 and 600. 12% of all municipalities lie within a road distance of 10 km to the next highway access point.

[Table 1 about here]

Municipalities in Mecklenburg-Western Pomerania are relatively small in terms of their area with an average size of 30 km<sup>2</sup>. Compared to studies that use counties as observational units, we pursue a more detailed geographical analysis. The geographical level plays an important role in case of relocation effects. An analysis at the aggregate (county) level is unable to uncover possibly large between-municipality movements of residents or firms.

## 4.2 Identification and regression specifications

To estimate how highway accessibility influences tax factors, we exploit variation across space and variation in time, since the highway was opened in different segments throughout

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<sup>11</sup>Left-wing votes combine votes for the social democratic *SPD*, the green party *Grüne*, and the left party *Die Linke/PDS*.

<sup>12</sup>Unemployment rates at the municipal level are available since 1998; For 37 observations, there are no unemployment data available due to municipality mergers.

our period of study (see figure A1 in the Appendix). We estimate the following difference-in-differences model:

$$\tau_{it} = \delta_i + \theta_t + \beta Access_{it} + X'_{it}\lambda + \epsilon_{it} \quad (1)$$

with  $\tau_{it}$  as our dependent variable, the local tax factor of municipality  $i$  in year  $t$ . The dummy  $Access_{it}$  denotes a measure of transportation infrastructure external to municipality  $i$ . It takes the value of 1 when a municipality is within a road distance of 10 km to the next highway access point, and zero otherwise.<sup>13</sup>  $X'_{it}$  is a vector of location and time-specific covariates (see section 4.1).  $\delta_i$  denotes location-specific time-invariant unobservables (like distance to large cities, airports, harbors),  $\theta_t$  denotes common time effects for all locations and  $\epsilon_{it}$  is the time-varying location-specific error. Our coefficient of interest is  $\beta$ , which measures the effect of access to the highway network on municipalities' choice of tax factors.

Identification relies on the main assumption that municipalities with a highway access would have evolved similar to municipalities without a highway access in the hypothetical case without a new highway. To estimate a causal effect, two conditions have to be met. First, treatment and control municipalities should follow a common trend before the opening of the highway. To show that this condition is fulfilled, we extend equation (1) and estimate an event study of the following form:

$$\tau_{it} = \delta_i + \theta_t + \sum_{j=c}^C \beta_j Access_{it}^j + X'_{it}\lambda + \epsilon_{it} \quad (2)$$

Compared to equation (1) we replace the dummy  $Access_{it}$  by a vector of dummies measuring the years before and after a municipality gained access to the highway.  $\sum_{j=c}^C \beta_j$  describes our coefficients of interest.  $Access_{it}^j$  takes on the value of 1 when a municipality  $i$  is within a road distance of 10 km to the next highway access point in  $(t + j)$  years and 0 otherwise. We include five dummies measuring the years before a municipality gains access (*-5 and less* to *-1*) and five dummies measuring the years after a municipality gains access (*1 to 5 and more*). The year before the highway opened serves as our base category. Therefore,  $j$  ranges from  $c = -5$  and less to  $C = +5$  and more, excluding  $-1$  (base category). Event studies not only enable us to test the common trend assumption equation (1) rests on, they also give a more detailed picture of the highway effects over time.

The second assumption for a causal interpretation of our results is an exogenous source of variation. The location of highways is likely endogeneous to regional patterns because they are built to connect economic units. Location-specific factors, like productivity or amenity, which are generally unobserved, may influence the location of infrastructure and

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<sup>13</sup> Additionally, we estimate specifications for  $Access_{it}$  with road distance of 5 km, 15 km, 0-5 km, 5-10 km and 10-15 km as well as continuous, see table 6.

the choice of tax factors (Redding and Turner, 2015). To reduce concerns of endogeneity, we follow the inconsequential units approach and focus on non-agglomeration areas (Banerjee *et al.*, 2012; Chandra and Thompson, 2000; Faber, 2014; Möller and Zierer, 2018). Non-agglomeration regions often receive access to a new highway because they lie on a convenient route between two larger cities that are connected. Moreover, for these rather rural municipalities, the exact opening year can be regarded as close to random and exogenous to their development (Fretz *et al.*, 2017). While Chandra and Thompson (2000) and Möller and Zierer (2018) focus only on peripheral regions and assume exogeneity<sup>14</sup>, Banerjee *et al.* (2012) draw straight lines to connect nearest neighbor pairs of historical cities and ports. Faber (2014) uses an IV approach and constructs a hypothetical least cost path spanning tree network. Figure 1 shows that the highways in MV connect the larger centers Rostock, Wismar, Schwerin, Greifswald, and Neubrandenburg with Berlin, Hamburg, Lübeck, and Magdeburg in nearly straight lines. We follow Chandra and Thompson (2000) and Möller and Zierer (2018) and concentrate only on non-agglomeration municipalities, while excluding the larger cities connected by the highway.

The main planning and investments in high level transportation infrastructure in Germany are made at the federal level, not the local level. The planning of the course of the BAB 20 followed environmental, economic, spatial, and traffic concerns. First, a southern course was excluded, and a broader environmentally sustainable corridor in the north was defined to connect the coastline. Second, an environmental impact study was conducted, and it covered 6,300 km<sup>2</sup>, or a quarter of the area in MV. Several variants were worked out and compared before the course of the highway was determined (BMVBW *et al.* 2007). With the special environmental territory in MV (MV has more national parks than any other German state), the course of the highway, and hence which municipality got connected, was not predominantly determined by economic reasons. To further strengthen the inconsequential units approach, we estimate equation (1) with two sub-samples where we first exclude municipalities whose location is classified as “central” and second exclude municipalities whose structure is classified as “predominantly urban”. Moreover, to examine a potential difference between central and peripheral municipalities we conduct a heterogeneity analysis considering the location of each municipality in our baseline regression (1).

One may argue that municipalities that lie between two larger cities are not comparable to municipalities that are located in the hinterland. They could, even without the construction of a new transportation network, follow a different growth path, because municipalities located between two larger cities may be more accessible in the first place. Table 2 shows the mean of population (log), share of population between age 15 and 65, and population

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<sup>14</sup>Möller and Zierer (2018) use the inconsequential units approach as a robustness test. Their main specification relies on historical instrumental variables. With both strategies they find “remakably similar results” for Germany (p.19).

density for different clusters of municipalities, depending on their road distance to the next access in 2015 and their location before the first highway segment opened.<sup>15</sup> The upper part of table 2 shows that municipalities located less than 10 km and more than 10 km from the next highway access in 2015 have a similar demographic structure in 1995 and 1996. This indicates that municipalities are comparable, regardless of whether or not they are located close to the future highway and therefore between two larger cities. Furthermore, the lower part of table 2 shows that central and peripheral municipalities also did not differ in these demographic outcomes.

[Table 2 about here]

Table 3 shows that demographic, economic, and political outcomes are not correlated with receiving highway access. We estimate survival models with getting a highway access within 10 km road distance as the failure event using Cox regressions. Demographic factors, unemployment rate, number of firms, employment, commuter pattern and election outcomes do not turn out to significantly alter the hazard rate. We conclude that pre-reform characteristics do not predict sorting into treatment. Also, municipalities that are classified as tourism destinations do not turn out to statistically influence the hazard rate.<sup>16</sup>

[Table 3 about here]

Figure 2 shows that our panel is well balanced. Between 1998 and 2007 the share of municipalities within a road distance of 10 km to the next highway access increased steadily and somewhat proportionally over time. Temporal clustering, therefore, should not be a problem.

[Figure 2 about here]

## 5 Results

### 5.1 Difference-in-Differences

Table 4 columns 1 and 4 show our baseline regression results for the property tax factor and the business tax factor. All specifications include municipality-fixed effects to account

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<sup>15</sup>Economic proxies like unemployment, number of firms or number of employed workers and commuters are not available for 1995 and 1996.

<sup>16</sup>Tourism destinations are municipalities listed as resorts, health resorts, spa, coastal resorts, and coastal health resorts by the Statistical Office of Mecklenburg-Western Pomerania in 2015.

for variation in average tax factors between municipalities and year-fixed effects to address temporary shocks that are common to all municipalities. Differences in local tax factors could be a result of different local preferences for public goods. Our estimation strategy accounts for these preference-related differences between municipalities, but changing preferences over time within municipalities could be a confounding factor. We control for population, population age categories, population density, and the share of left-wing votes at local and state elections. Since these variables could at the same time be influenced by highway accessibility, we include them as lags.

[Table 4 about here]

For the property tax factor, the influence of highway access is positive and statistically significant at the 1% level. Municipalities whose road distance to the next highway access does not exceed 10 km have property tax factors that are on average 6.2 percentage points higher compared to less accessible municipalities. This effect corresponds to roughly 2% relative to the average property tax factor and is therefore economically sizable, but moderate. For the business tax factor (column 4), however, we do not find any statistically significant effect of improved highway accessibility. Generally, the baseline model fits the property tax factor relatively well, accounting for 49% of its within variation, while explaining only 30% of the within variation in business tax factors.

Strengthening the argument of the inconsequential units approach, we in turn exclude central and predominantly urban municipalities.<sup>17</sup> Central and peripheral municipalities are classified based on the accessibility of concentrations of population and employment, while the structural categories urban and rural are determined by population density and settlement area measures. Due to the spatial structure of MV, only few municipalities, namely those surrounding the cities Rostock and Wismar, are defined as central. Against this background, the 11% increase in the coefficient for the 10 km dummy in column 2 of table 4 when excluding these municipalities is sizable. The effect size corresponds to 2.2% of the average property tax factor, while the respective coefficient for the business tax factor (column 5) again does not turn out to be statistically significant. Thus, the overall positive property tax differential after the highway opening seems to be primarily driven by (very) peripheral localities without immediate access to populous and economically active urban centers. Structural factors, i.e., whether the municipality itself is of (predominantly) urban or rural type, however, do not play a crucial role. Results in columns 3 and 6 closely resemble those in columns 1 and 4.

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<sup>17</sup>The spatial categories are defined by the Federal Institute for Building, Urban Affairs, and Spatial Research (BBSR).

In an attempt to corroborate the baseline findings of table 4, we conduct several robustness checks. First, we include municipality-specific linear time trends to rule out the possibility that accessible municipalities – defined as falling under the 10 km distance band – and less accessible localities were already on differential growth paths in their outcome variables. In this case, we would find an effect on local tax factors even in the absence of the construction of the BAB 20. However, these concerns are not supported by the results as columns 1 and 4 in table 5 demonstrate. For the property tax factor, the positive differential between accessible and less accessible municipalities persists. Compared to the baseline estimates, coefficients are slightly smaller, suggesting that part of the treatment effect is absorbed by the time trends. Second, we extend the set of control variables and control for the unemployment rate and market access to Poland. Since the unemployment rate could at the same time be influenced by highway accessibility, we include it with a lag. As columns 2 and 5 in table 5 show, results remain unchanged. Third, we exclude all control variables (table 5, columns 3 and 6). The results fairly reproduce our baseline findings.

[Table 5 about here]

Fourth, with its many national parks and its location at the Baltic Sea, MV is a popular tourism destination. As touristic municipalities might benefit particularly from better accessibility, we exclude them in a further robustness test. Our baseline results remain unchanged (see table A3 in the appendix). Fifth, we follow Bertrand *et al.* (2004) and estimate a pooled OLS. Ignoring the time dimension accounts for a possible inconsistency of the standard errors. Table A4 in the appendix shows that our baseline results hold.

Finally, table 6 repeats our baseline analysis when using alternative specifications of the distance variable to ease concerns about arbitrary cutoff-values. In columns 1 and 2 as well as 5 and 6, we specify the treatment dummy to equal one for municipalities within a road distance of 5 km and 15 km, respectively. In columns 3 and 7, we differentiate the effect for those distance bands by simultaneously including all 5 km sub-categories (as dummies). The results yield some interesting insights. Namely, our baseline finding of a positive property tax differential is restricted to municipalities within a distance band of 5 to 10 km from the next highway access (column 3). The fact that municipalities located in even closer proximity to the highway – less than 5 km – or between 10 and 15 km do not react in terms of property tax factors (columns 1 and 3), explains the estimated average zero effect in column 2. What is more, coefficients for the maximum distance band in column 3 even display opposite signs suggesting counteracting effects on the property tax factor. This is also true for the business tax factor (column 6), where the coefficient of the 10 to 15 km distance dummy is negative



and statistically significant at the 5% level. In columns 4 and 8 we include the road distance to the next highway access as a continuous measure. Our baseline results are confirmed.<sup>18</sup>

[Table 6 about here]

## 5.2 Event Studies

Our baseline effects in table 4 measure averages over all municipality-year observations characterized by improved access to the highway following equation (1). To discern temporary patterns in the local tax setting, we normalize the year of improved accessibility for all municipalities and build a categorical variable taking on different values for a time window of 5 years around the opening of the highway segment (equation (2)). Figure 3 displays the coefficient estimates and their 90% confidence intervals graphically. All effects are relative to the year before the opening of the highway segment (indicated by the dashed line).

[Figure 3 about here]

The observed patterns for the property and business tax factors are relatively similar, although confidence bands for the estimates on the business tax factor are larger, which explains why we do not find an average effect in our baseline regressions. For both tax factors, effect sizes oscillate around five percentage points, although – in line with previous results – the increase in the property tax factor is more precisely estimated and persistent compared to that of the business tax factor. Four years after the opening of the highway segment – and thus after falling under the 10 km distance band – the estimate for the positive business tax differential gets less precise and lacks statistically significant. Reassuringly, tax factors are not adapted in the four years before the opening which is consistent with the relatively quick planning procedure precluding local decision makers from targeting specific locations. As we do not observe statistically significant differences in tax factors in the years before the highway was opened (90% confidence intervals always include the zero), the common trend assumption seems to be met.

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<sup>18</sup>The effect on the property tax factor is negative, which confirms our baseline finding of a positive effect when municipalities get closer to highway access. During our sample period, no highway was closed, only opened. Municipalities therefore experienced no change or a reduction in their distance to the next highway. With negative distance changes, the coefficient has to be multiplied by -1 to interpret it as the effect of getting closer to the next highway access.

### 5.3 Mechanisms

The average estimated effects of the baseline specifications might mask substantial heterogeneities in municipal tax setting. Conditional on the spatial characteristics of a municipality, for example, policymakers might have more or less scope for tax rate changes in the first place, and, more importantly, might be affected differently by increased accessibility. For this reason, we re-estimate our baseline specification by adding multiplicative interactions between the treatment indicator and dummy variables for central and peripheral municipalities. Table 7 displays the results. Peripheral municipalities that receive a highway access within 10 km increase their property tax factors by 6.91 percentage points (column 1). This effect corresponds quite closely to the one displayed in column 2 of table 4 where we excluded central municipalities from the specification. The positive property tax differential for peripheral municipalities persists for the different control variants in columns 2 to 4. Central municipalities do not seem to adjust their tax factors. Similar to previous results, the effects for business tax factors do not turn out to be statistically significant.

[Table 7 about here]

We investigate possible mechanisms to explain the positive property tax factor differential for accessible municipalities. Effects could run through population, employment, or area-based channels, which we investigate in turn in table 8 with a parsimonious specification. Panel A shows how these variables are affected by accessibility. Most of the coefficients are very imprecisely estimated, but some employment measures seem to matter. Receiving a highway access within 10 km is associated with a decrease in the number of firms, the number of employed workers in the municipality, and the number of inbound commuters. Similar to table 7, panel B repeats the analysis when including an interaction term between the treatment indicator and the central/periphery-dummy. While effect sizes in peripheral locations – relative to central municipalities – are moderate, they nevertheless reveal a striking pattern: For all variables, we observe negative effects when peripheral municipalities fall within 10 km road distance to the next highway access. The respective municipalities lose around 4% of their overall and working population, rendering them less densely populated. Also the overall employment situation deteriorates, with the adverse effects on the number of local employees and inbound commuters being especially pronounced. And buildings with residential areas, which are a main part of the tax base of the property tax, decrease. For central municipalities, we observe exactly the opposite pattern. Effect sizes are large and positive throughout, i.e., central municipalities seem to benefit in terms of population and employment with increased highway accessibility. The

small number of municipalities classified as central, however, raises questions about sample size and how reliable the estimate for central municipalities actually is.

[Table 8 about here]

The effect of highway accessibility on tax factors can also run via property values reflected in prices. We test this channel with real estate advertisement data from 2005 to 2015 containing a large battery of object characteristics and the offer price.<sup>19</sup> Table A5 in the Appendix presents summary statistics for the variables used in our analysis covering sales of detached houses, apartment buildings, condominiums and commercial properties between 2005 to 2015 in MV. Unfortunately, the data coverage does not overlap with the main construction window of the BAB 20 such that variation in the access variable is low.<sup>20</sup> Therefore, the results presented in table 9 should be viewed as suggestive. We run pooled OLS estimations at the object level, controlling for municipality and year fixed effects, our baseline political and population variables and object characteristics. The dependent variable is the object price per  $m^2$ . The results show a clear pattern of reduced offer prices across all property types. Detached houses within 10 km road distance to the next highway access are offered at around €165 less per  $m^2$  than detached houses further away. Results in panel B show that the negative price effects are largest in the second distance band (5-10 km). Once we move further away from the highway access, prices for apartment buildings, condominiums and commercial property are insensitive to highway accessibility.

[Table 9 about here]

Moreover, we investigate how highway accessibility influences tax revenues with our parsimonious specification. Table 10 shows results for absolute tax revenues (*Istaufkommen*, columns 1 and 3) and tax factor adjusted revenues (*Grundbetrag*, columns 2 and 4).<sup>21</sup> Tax factor adjusted revenues allow for a comparison of tax revenues between municipalities with different tax factors as municipalities with a similar tax base may have different revenues simply because they set tax factors differently. Overall, property tax revenue is not affected (panel A). Disentangling effects between peripheral and central municipalities in panel B, however, shows that changes in accessibility may well map into changes in tax revenues. Peripheral municipalities experience a decrease in tax factor adjusted property tax revenues. This implies that peripheral municipalities close to a new highway access –

<sup>19</sup>The data was collected by F+B, a commercial real estate consultancy firm, and covers roughly 18 million properties that were offered for sale in Germany during the period from January 2005 until December 2018.

<sup>20</sup>Because of the low variation in the shorter time window we cannot conduct a heterogeneity analysis between peripheral and central municipalities.

<sup>21</sup> $\text{tax factor adjusted revenues} = \text{revenue} \cdot 100 / \text{tax factor}.$

compared to the baseline category of peripheral municipalities without an access – increase their property tax factors to keep their absolute property tax revenues stable (see table 7). In central municipalities, on the other hand, absolute and adjusted property tax revenues remain unchanged. Turning to business taxes, neither absolute nor tax factor adjusted revenues are significantly altered in the medium-run.

[Table 10 about here]

## 6 Discussion

On average, our results suggest that peripheral municipalities in MV that gained immediate access to the newly constructed highway BAB 20 in the aftermath of German reunification increased their property tax factors. This effect proves to be persistent and very robust across specifications, conditioning factors, and estimation methods. Business tax factors, the other local tax that German municipalities have discretion over, appear to be unaffected by improved accessibility.

We examine population and employment-related channels for the property tax effect. On average, improved highway accessibility is associated with a decrease in firms per capita, the number of employees working (but not living) in the municipality, and inbound commuters. Furthermore, house prices seem to decline in municipalities close to a highway access. Since our baseline findings are driven by peripheral municipalities, we distinguish between central and peripheral municipalities to unmask possible heterogeneous effects as discussed in section 2. Again, the average negative effects for the examined channels can be traced back to peripheral municipalities, while their central counterparts benefit on all margins. This suggests that in peripheral municipalities deagglomeration forces outweigh agglomeration forces and vice versa for core municipalities. In line with theoretical predictions by the core-periphery model, improved accessibility, i.e., a decline in trade costs, leads to a shift of population and employment to central municipalities at the expense of the periphery. Against the background of relatively equal populations between central and peripheral municipalities preceding the construction of the BAB 20 (see table 2, panel B), this finding is especially striking. However, effect sizes for the regional centers should be interpreted with caution, since central municipalities make up only 2% of our sample.

Our findings can be rationalized by new economic geography models that state a home market effect amplified by population mobility. Upon construction of the BAB 20, falling transport costs reduce the degree of trade protection in the periphery, and there might be substitution away from local production. Population and the number of firms is reduced

in peripheral municipalities. In the long term, reducing transportation costs gives rise to concentration, i.e., to an agglomeration-periphery structure rather than to a uniform distribution between regions.

As a result of a shift in employment and population, peripheral municipalities lose part of their tax base. On the one hand, adverse effects for employees commuting to work in peripheral municipalities are especially pronounced, and they suggest a general decline in local economic activity that might in the long-run be reflected in business tax revenues. On the other hand, the municipality share in income tax revenue is distributed according to employees' place of residence, another location condition that is negatively affected by accessibility via the BAB 20. Counteracting these tax base effects with an increase in property tax factors to keep tax revenues stable seems a rational response by local policymakers. First, property tax revenues are relatively stable due to the immobile nature of the tax base.<sup>22</sup> Second, the outdated legal provisions of the German property tax do not take value adjustments into account, i.e., tax factors are the only instrument at the discretion of local policymakers. This argument is especially important given the suggestive evidence of falling house prices close to the new highway network.

## 7 Conclusion

We focus on an episode of extensive highway construction in East Germany following reunification and examine how access to the highway network influences municipal tax policy. Getting access to a highway reduces transportation costs and increases attractiveness of municipalities as residential and firm locations. This may be an asset in the local competition for capital and labor and induce changes in tax policy choices of the local government.

We consider the opening of highway number 20 that runs through the German state of Mecklenburg Western-Pomerania. The construction of the BAB 20 is the largest contiguous highway construction project since 1945 in Germany. With its opening, the average distance of municipalities in MV to the next highway access was more than halved. In the baseline estimation, we use the difference-in-differences approach. The stagewise opening of the highway also allows us to exploit variation in the timing of access in event study estimations. Our sample includes 745 municipalities over the 1995 to 2015 period. We follow the inconsequential units approach and exclude large cities that shape the route of the BAB

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<sup>22</sup>Property tax does not depend on whether a property is inhabited or not. If one moves to another municipality, one has to pay property tax to the "old" property until it is sold, then the new owner pays property tax. The tax base can be reduced, for instance, by the conversion of built-up land into undeveloped land.

20. Highways are likely built to connect economic units, but peripheral municipalities often receive access to the highway network because they “accidentally” lie on a convenient route between two larger cities. Therefore, the connection to the highway network as well as the exact timing of access is close to random in peripheral municipalities.

Our results suggest that municipalities within 5 to 10 km road distance to a new highway access increase their property tax factors. Using event studies, we show that there is no adjustment in tax factors in the four years prior to the highway opening, but tax factors start to rise immediately afterwards. In line with the baseline findings, more accessible municipalities increase their property tax factors persistently, while the business tax differential falls to zero four years after the opening of the highway segment. Finally, we reconcile our findings with the literature by examining the role of economic outcomes as possible drivers of the tax policy effect. While the benefits of central municipalities in terms of population and employment seem implausibly large to be solely attributable to the highway construction, the negative pattern for peripheral municipalities that gain close access is striking. As a result, municipalities might resort to increased property tax factors to stabilize their tax revenues.

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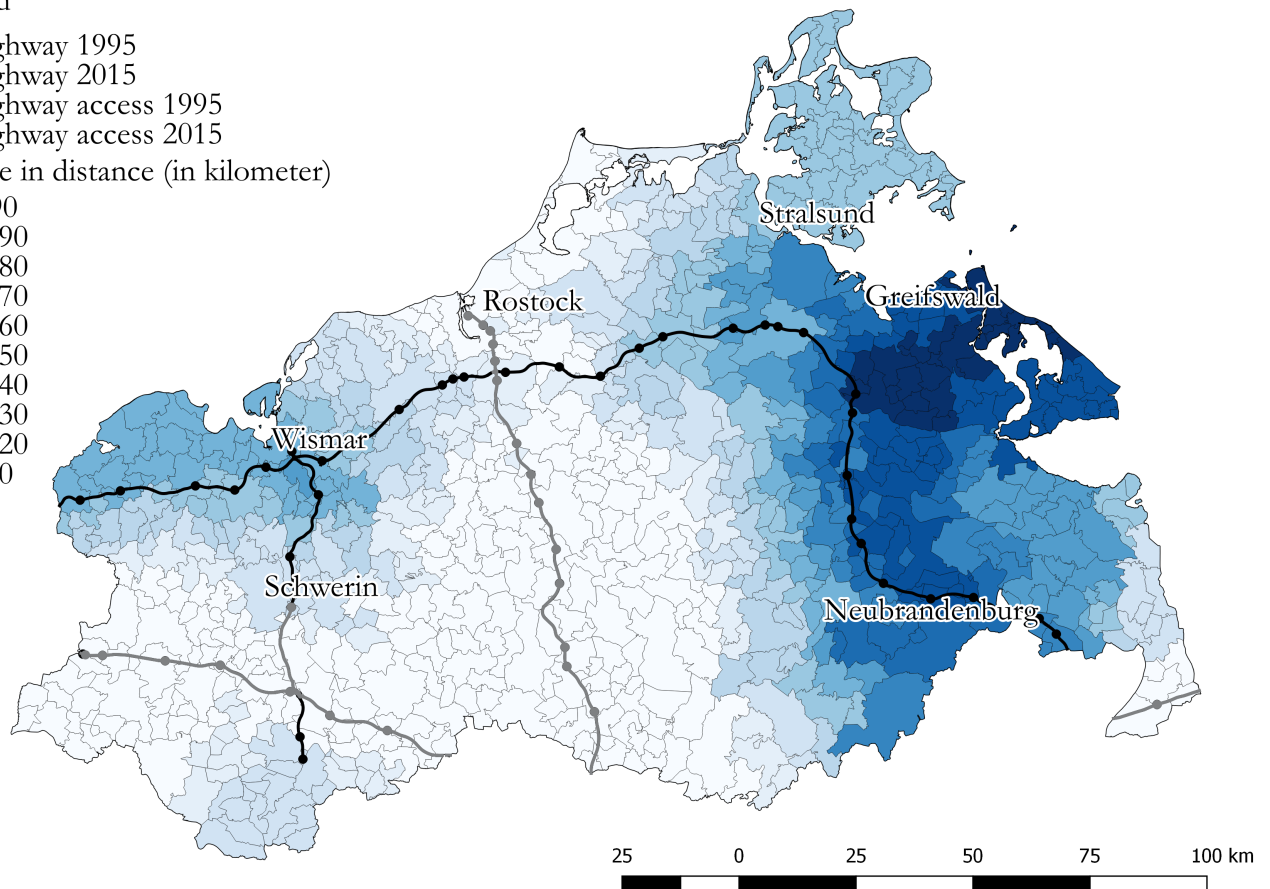
Figure 1: Highway network 1995 and 2015

Legend

- Highway 1995
- Highway 2015
- Highway access 1995
- Highway access 2015

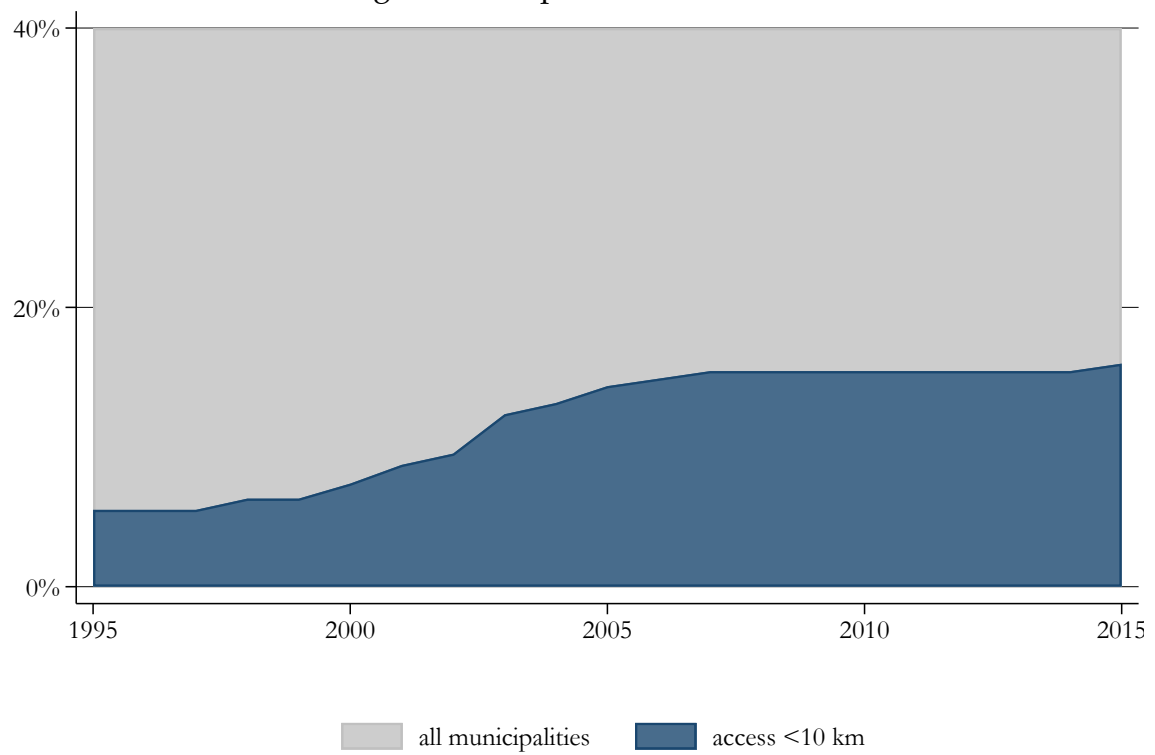
Change in distance (in kilometer)

- > 90
- 80-90
- 70-80
- 60-70
- 50-60
- 40-50
- 30-40
- 20-30
- 10-20
- 0-10
- 0



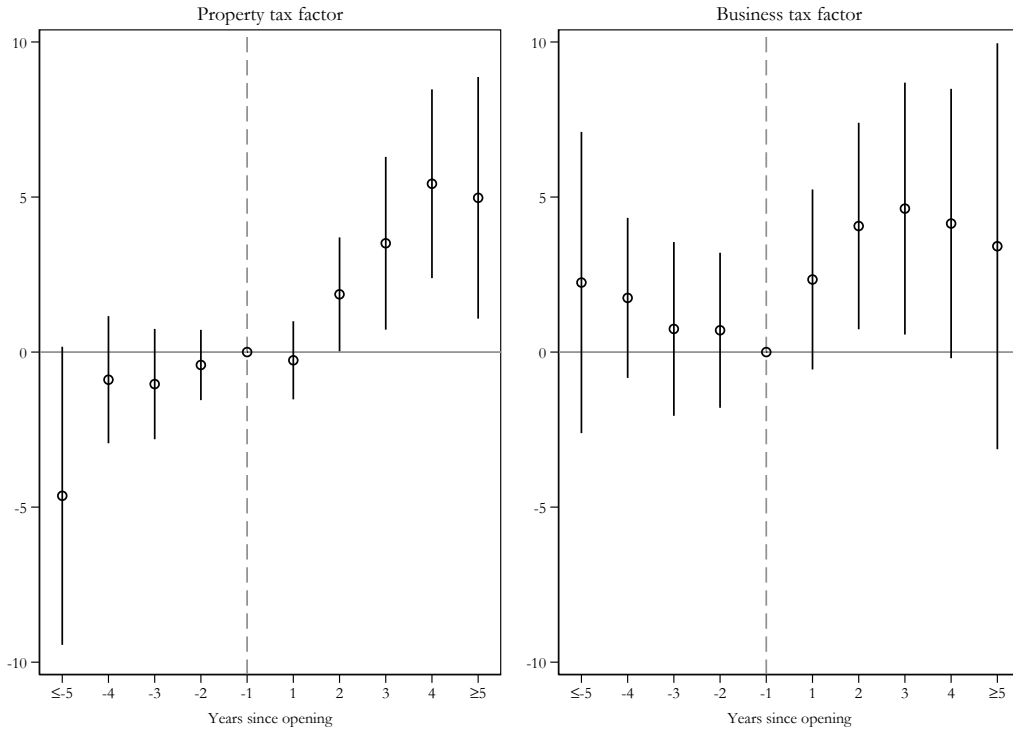
*Notes:* The map shows the municipalities of the German state of Mecklenburg-Western Pomerania (light gray borders). The highway network (access points) of 1995 is depicted in dark gray lines (points); black lines (points) represent the highway network (access points) of 2015. Municipalities are shaded according to the change in road distance to the next highway access point between 1995 and 2015.

Figure 2: Sample balancedness



*Notes:* The figure shows the cumulative share of municipalities within a road distance of 10 km to the next highway access point between 1995 and 2015.

Figure 3: Event study results



*Notes:* The figures show the results of two event-study estimations. Vertical dashed lines represent the year when a municipality falls within a road distance of 10 km to the next highway access point. The 745 municipalities of the German state of Mecklenburg-Western Pomerania are our observation units. We use yearly data in levels during the period 1995 to 2015. Circles are point estimates, and black lines represent the 90% confidence interval. We include year and municipality-fixed effects and control variables (see notes to table 4).  $Year = -1$  is the base category. We use standard errors robust to heteroskedasticity.

Table 1: Descriptive statistics

	Observations	Mean	SD	Min	Max
<i>Dependent variables</i>					
Business tax factor	15,645	291.83	38.14	100.00	450.00
Property tax factor	15,645	316.11	27.75	200.00	600.00
<i>Access dummy (yes = 1)</i>					
Access (<10 km)	15,645	0.12	0.32	0.00	1.00
<i>Control variables</i>					
Population (log)	15,645	6.74	0.98	4.62	10.46
Age: < 15, share	15,645	13.71	3.37	3.33	31.27
Age: between 15 and < 25, share	15,645	11.46	3.47	0.98	40.18
Age: between 25 and < 40, share	15,645	19.05	4.16	5.15	41.88
Age: between 40 and < 65, share	15,645	38.41	6.03	12.37	62.14
Population density	15,645	52.11	63.88	4.91	632.94
Election county assembly, share left	15,645	46.17	6.89	32.50	61.80
Election state assembly, share left	15,645	57.64	4.62	50.40	62.70
Election mayor, share left	15,645	17.09	19.40	0.00	100.00
<i>Further control variables</i>					
GDP poland · distance	15,645	7,344.06	26,243.78	546.88	683812.00
Unemployment rate	13,410	11.81	5.12	0.00	36.42

*Notes:* The 745 municipalities of the German state of Mecklenburg-Western Pomerania are our observation units. We use yearly data between 1995 and 2015. The dummy variable *Access* equals one when a municipality is within a certain road distance to the next highway access point, and zero otherwise. *GDP poland · distance* is GDP in Poland multiplied by the inverse linear distance of each municipality to the Polish border.

Table 2: Sorting into treatment – t-tests

<i>A: Distance to access</i>	Mean road distance to next access in 2015 < 10km	Mean road distance to next access in 2015 > 10km	Diff	SD	Obs
Population (log)	6.78	6.73	0.05	0.10	745
Poulation age 15-65 (log)	6.39	6.34	0.04	0.10	745
Population density	52.55	49.28	3.27	6.33	745
<i>B: Location of municipalities</i>	Mean central municipalities	Mean peripheral municipalities	Diff	SD	Obs
Population (log)	6.77	6.81	-0.05	0.24	745
Poulation age 15-65 (log)	6.38	6.46	-0.08	0.24	745
Population density	51.64	68.50	-16.86	15.52	745

*Notes:* The 745 municipalities of the German state of Mecklenburg-Western Pomerania are our observation units. We use yearly data before the first highway segment was opened – 1995 and 1996.



Table 3: Sorting into treatment – Cox regression

	(1)	(2)	(3)	(4)
Population (log)	-1.29 (1.69)	-1.40 (2.27)	-1.32 (2.33)	-0.83 (2.35)
Population age 15-65 (log)	1.27 (1.67)	0.93 (2.41)	0.87 (2.52)	0.48 (2.51)
Population density	-0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Unemployment rate		0.02 (0.03)	0.02 (0.04)	0.02 (0.04)
Firms (per capita)		-22.82 (14.23)	-23.26 (14.64)	-11.92 (17.57)
Employed place of residence (log)		0.37 (0.83)	0.38 (0.84)	0.29 (0.85)
Employed place of work (log)		0.22 (0.39)	0.23 (0.39)	0.22 (0.38)
Inbound commuter (log)		-0.12 (0.34)	-0.12 (0.33)	-0.15 (0.33)
Outbound commuter (log)		-0.13 (0.13)	-0.13 (0.13)	-0.14 (0.13)
Election mayor, share left			-0.00 (0.01)	-0.00 (0.01)
Election county assembly, share left			-0.01 (0.03)	-0.01 (0.03)
Tourism destination				-1.71 (1.26)
Pseudo $R^2$	0.00	0.01	0.01	0.01
Observations	13909	9751	9751	9751

*Notes:* The 745 municipalities of the German state of Mecklenburg-Western Pomerania are our observation units. The Cox regressions estimate a survival model with receiving a highway access within 10 km road distance as the failure event. Tourism destinations are municipalities listed in 2015 as resorts, health resorts, spas, coastal resorts, and coastal health resorts by the Statistical Office of Mecklenburg-Western Pomerania.

Table 4: DD Regression – Baseline

	Property tax factor			Business tax factor		
	(1)	(2)	(3)	(4)	(5)	(6)
Access (<10 km)	6.212*** (2.24)	6.886*** (2.59)	6.255*** (2.24)	2.740 (3.16)	4.160 (3.60)	2.693 (3.16)
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
W/o central mun.		Yes			Yes	
W/o urban mun.			Yes			Yes
Within $R^2$	0.493	0.491	0.493	0.305	0.307	0.306
Number of mun.	745	728	733	745	728	733
Observations	14900	14560	14660	14900	14560	14660

*Notes:* The table shows the results of six difference-in-differences estimations. The 745 municipalities of the German state of Mecklenburg-Western Pomerania are our observation units. We use data in levels over the period 1995 to 2015. Our variable of interest (Access) takes on the value of one for municipalities within a road distance of 10 km to the next highway access point, and zero otherwise. Columns (1) and (4) show our baseline specification; columns (2) and (5) show regression results for the sub-sample where municipalities classified as being “central” (location) are excluded; columns (3) and (5) show regression results for the sub-sample where municipalities classified as being “predominantly urban” (structure) are excluded. Control variables are lagged demographic and political variables; see table 1. Significance levels (standard errors robust to heteroskedasticity in brackets): \*\*\* 0.01, \*\* 0.05, \* 0.10.

Table 5: DD Regression – Robustness

	Property tax factor			Business tax factor		
	(1)	(2)	(3)	(4)	(5)	(6)
Access (<10 km)	5.926*** (2.24)	5.641** (2.35)	6.237*** (2.25)	2.191 (3.18)	0.703 (3.08)	3.155 (3.18)
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes		Yes	Yes	
Time trend	Yes			Yes		
Further controls		Yes			Yes	
Within $R^2$	0.494	0.492	0.488	0.306	0.330	0.292
Number of mun.	745	745	745	745	745	745
Observations	14900	12665	15645	14900	12665	15645

*Notes:* The table shows the results of six difference-in-differences estimations in three different robustness tests. The 745 municipalities of the German state of Mecklenburg-Western Pomerania are our observation units. We use data in levels during the period 1995 to 2015. Our variable of interest (Access) takes on the value of one for municipalities within a road distance of 10 km to the next highway access point, and zero otherwise. Column (1) and (4) show regression results including a municipality specific time trend; column (2) and (5) show regression results including lagged unemployment rate and GDP in Poland multiplied with the inverse linear distance of each municipality to the polish border; column (3) and (6) show regression results without control variables. Control variables are lagged demographic and political variables; see table 1. Significance levels (standard errors robust to heteroskedasticity in brackets): \*\*\* 0.01, \*\* 0.05, \* 0.10.

Table 6: DD Regression – Different distance bands

	Property tax factor				Business tax factor			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Access (<5 km)	3.881 (2.96)		3.858 (2.99)		9.632 (5.94)		8.641 (6.05)	
Access (<15 km)		1.460 (1.60)				-1.801 (2.00)		
Access (5-10 km)			6.811** (3.05)				-1.628 (3.52)	
Access (10-15 km)			-1.983 (1.69)				-4.628** (2.05)	
Distance to access (km), cont.				-0.036** (0.02)				0.021 (0.03)
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Within $R^2$	0.492	0.492	0.493	0.492	0.306	0.305	0.306	0.305
Number of mun.	745	745	745	745	745	745	745	745
Observations	14900	14900	14900	14900	14900	14900	14900	14900

*Notes:* The table shows the results of eight difference-in-differences estimations. The 745 municipalities of the German state of Mecklenburg-Western Pomerania are our observation units. We use data in levels during the period 1995 to 2015. Our variable of interest (Access) takes on the value of one for municipalities within a certain road distance to the next highway access point, and zero otherwise. Control variables are lagged demographic and political variables, see table 1. Significance levels (standard errors robust to heteroskedasticity in brackets): \*\*\* 0.01, \*\* 0.05, \* 0.10.

Table 7: Baseline with location heterogeneity

	Property tax factor				Business tax factor			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Access (<10 km) periphery	6.907*** (2.58)	6.605** (2.58)	5.895** (2.60)	7.206*** (2.59)	4.282 (3.60)	3.706 (3.62)	1.445 (3.38)	5.090 (3.63)
Access (<10 km) central	2.222 (2.66)	2.029 (2.65)	3.335 (2.37)	0.939 (2.42)	-6.127 (4.00)	-6.495 (4.05)	-6.041 (3.96)	-7.426* (3.81)
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ontrols	Yes	Yes	Yes		Yes	Yes	Yes	
Time trend		Yes				Yes		
Lagged controls			Yes				Yes	
Within R <sup>2</sup>	0.493	0.494	0.492	0.489	0.305	0.307	0.330	0.293
Number of mun.	745	745	745	745	745	745	745	745
Observations	14900	14900	12665	15645	14900	14900	12665	15645

*Notes:* The table shows the results of eight difference-in-differences estimations. The 745 municipalities of the German state of Mecklenburg-Western Pomerania are our observation units. We use data in levels during the period 1995 to 2015. We interact our Access dummy (1 for municipalities within a road distance of 10 km to the next highway access point, and zero otherwise) with a dummy for central (peripheral) municipalities, which is one for municipalities that are classified as being central (peripheral), and zero otherwise. Columns (1) and (5) show our baseline specification; columns (2) and (6) show regression results including a municipality specific time trend; columns (3) and (7) show regression results including lagged control variables (population (log), population density, age shares (younger than 15, between 15 and 25, between 25 and 40, between 40 and 65), election outcomes (share left in state assembly, district assembly, and mayor elections), unemployment rate); columns (4) and (8) show regression results without control variables. Control variables are lagged demographic and political variables, see table 1. Significance levels (standard errors robust to hereroskedasticity in brackets): \*\*\* 0.01, \*\* 0.05, \* 0.10.

Table 8: Channels

	Population			Firms	Employment		Commuter		Buildings
	(1) all (log)	(2) age 15-65 (log)	(3) density	(4) (log)	(5) place of residence (log)	(6) place of work (log)	(7) Inbound (log)	(8) Outbound (log)	(9) with residential areas (log)
<i>A: Baseline</i>									
Access (<10 km)	-0.004 (0.02)	0.003 (0.02)	0.135 (1.31)	-0.050* (0.03)	-0.016 (0.02)	-0.178* (0.09)	-0.169* (0.10)	0.014 (0.12)	0.003 (0.01)
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Within R <sup>2</sup>	0.309	0.394	0.0722	0.0590	0.102	0.0817	0.0639	0.00343	0.509
Number of mun.	745	745	745	737	745	745	745	745	745
Observations	15645	15645	15645	11934	11175	11141	11124	11175	2980
<i>B: Heterogeneity</i>									
Access (<10 km) periphery	-0.042*** (0.02)	-0.037** (0.02)	-2.414** (1.03)	-0.072** (0.03)	-0.041** (0.02)	-0.274*** (0.09)	-0.257*** (0.10)	-0.010 (0.13)	-0.022** (0.01)
Access (<10 km) central	0.203*** (0.04)	0.221*** (0.04)	14.074*** (4.34)	0.145*** (0.05)	0.200*** (0.02)	0.644*** (0.19)	0.586*** (0.21)	0.232 (0.15)	0.119*** (0.04)
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Within R <sup>2</sup>	0.328	0.410	0.0875	0.0611	0.117	0.0852	0.0673	0.00365	0.521
Number of mun.	745	745	745	737	745	745	745	745	745
Observations	15645	15645	15645	11934	11175	11141	11124	11175	2980

*Notes:* The table shows the results of nine difference-in-differences estimations. The 745 municipalities of the German state of Mecklenburg-Western Pomerania are our observation units. We use data in levels during the period 1995 to 2015. Data on firms for the years 1999 to 2015; data on employed and commuters for the years 1999 to 2013; data on buildings with residential areas aggregated for the periods 1996-2000, 2001-2004, 2005-2008, 2009-2011. We interact our Access dummy (one for municipalities within a road distance of 10 km to the next highway access point, and zero otherwise) with a dummy for central (peripheral) municipalities which is 1 for municipalities that are classified as being central (peripheral), and zero otherwise. Significance levels (standard errors robust to heteroskedasticity in brackets): \*\*\* 0.01, \*\* 0.05, \* 0.10.

Table 9: Channels - Real estate offers

	Detached house	Apartment building	Condominium	Commercial property
	(1)	(2)	(3)	(4)
<i>A: Baseline</i>				
Access (<10 km)	-165.446*** (23.54)	-205.924*** (50.57)	-345.724*** (50.94)	-248.473*** (81.38)
<i>B: Different distance bands</i>				
Access (<5 km)	-174.647*** (40.31)	-152.975*** (55.63)	-185.911* (99.44)	-165.473* (85.95)
Access (5-10 km)	-192.641*** (29.03)	-236.359*** (70.39)	-427.667*** (57.98)	-291.636*** (110.63)
Access (10-15 km)	-75.182*** (18.92)	102.178 (74.18)	-73.574 (47.95)	-321.938 (298.85)
Municipality FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Housing controls	Yes	Yes	Yes	Yes
Municipality controls	Yes	Yes	Yes	Yes
Within $R^2$	0.438	0.452	0.524	0.316
Observations	150,187	9,708	73,723	16,472

*Notes:* The table shows the results of eight pooled OLS estimations. The observation units are the real estate properties offered for sale in the municipalities of the German state of Mecklenburg-Western Pomerania. We use data in levels during the period 2005 to 2015. All specifications include municipality and year fixed effects, housing controls and municipality controls. Municipality controls are demographic and political variables, see table 1. Housing controls are the number of rooms, total area, year of construction, object type and postal code, see table A5. Significance levels (standard errors robust to heteroskedasticity in brackets): \*\*\* 0.01, \*\* 0.05, \* 0.10.

Table 10: Tax revenues

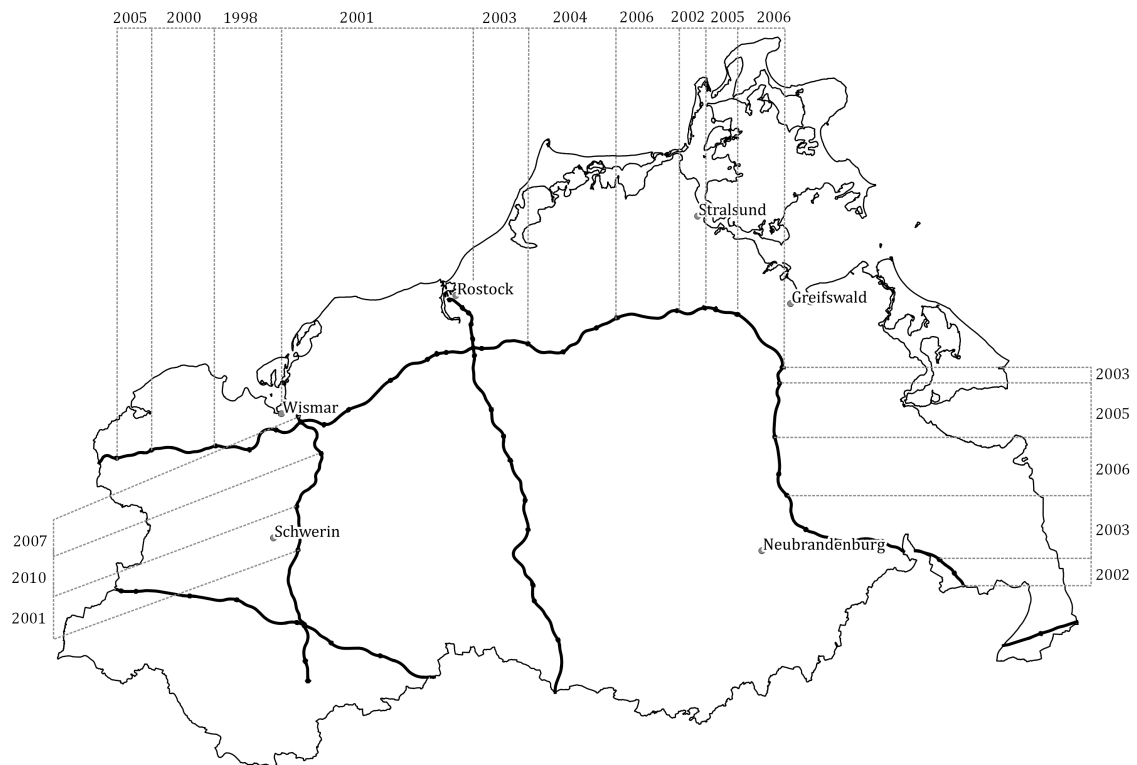
	Property tax revenue		Business tax revenue	
	(1) absolute (log)	(2) tax factor adjusted (log)	(3) absolute (log)	(4) tax factor adjusted (log)
<i>A: Baseline</i>				
Access (<10 km)	0.001 (0.01)	-0.017 (0.01)	0.058 (0.10)	0.057 (0.10)
Municipality FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Within $R^2$	0.525	0.419	0.295	0.257
Number of mun.	745	745	745	745
Observations	13405	13405	12730	12730
<i>B: Heterogeneity</i>				
Access (<10 km) periphery	-0.004 (0.01)	-0.024** (0.01)	0.088 (0.11)	0.084 (0.11)
Access (<10 km) central	0.038 (0.06)	0.030 (0.05)	-0.185 (0.14)	-0.168 (0.13)
Municipality FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Within $R^2$	0.525	0.419	0.295	0.257
Number of mun.	745	745	745	745
Observations	13405	13405	12730	12730

*Notes:* The table shows the results of four difference-in-differences estimations. The 745 municipalities of the German state of Mecklenburg-Western Pomerania are our observation units. We use data in levels during the period 1998 to 2015. *Tax factor adjusted revenue* is defined as  $revenue \cdot 100 / tax\ factor$ . It is used for comparisons between municipalities as it offsets the impact of different tax factors. We interact our Access dummy (1 for municipalities within a road distance of 10 km to the next highway access point, and zero otherwise) with a dummy for central (peripheral) municipalities which is 1 for municipalities that are classified as being central (peripheral), and zero otherwise. Control variables are lagged demographic and political variables, see table 1. Significance levels (standard errors robust to heteroskedasticity in brackets): \*\*\* 0.01, \*\* 0.05, \* 0.10.



## Appendix (for online publication only)

Figure A1: Opening of highway segments in Mecklenburg-Western Pomerania, 1995-2015



*Notes:* The map shows the highway network in the German state of Mecklenburg-Western Pomerania. Parts of the highway that were open 2002, 2003, and 2005 were not immediately connected to larger cities until 2006. These parts without continuous routing to a larger city amounted to 7.4 km in 2002, 14.2 km in 2003 and 2004, and 33.4 km in 2005.

Table A1: Road network in MV

year	National highway (in km)	National primary, state and county roads (in km)
1995	237	9,475
2015	554	9,434
$\Delta$	317	-41

*Notes:* This table shows the length of the road network in Mecklenburg-Western Pomerania in 1995 and 2015. The decrease in of the length in national primary, state and county roads is due to re-classification into municipal roads.

Table A2: Baseline without merged municipalities

	Property tax factor			Business tax factor		
	(1)	(2)	(3)	(4)	(5)	(6)
Access (<10 km)	5.692** (2.52)	6.404** (3.05)	5.724** (2.52)	1.503 (3.29)	2.893 (3.91)	1.442 (3.30)
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
W/o central mun.		Yes			Yes	
W/o urban mun.			Yes			Yes
Within $R^2$	0.468	0.465	0.467	0.281	0.284	0.283
Number of mun.	564	548	552	564	548	552
Observations	11280	10960	11040	11280	10960	11040

Notes: This table reproduces table 4 without merged municipalities. Significance levels (standard errors robust to heteroskedasticity in brackets): \*\*\* 0.01, \*\* 0.05, \* 0.10.

Table A3: Baseline without tourism destinations

	Property tax factor			Business tax factor		
	(1)	(2)	(3)	(4)	(5)	(6)
Access (<10 km)	4.736* (2.41)	5.242* (2.92)	4.667* (2.41)	1.585 (3.37)	2.964 (4.02)	1.532 (3.37)
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
W/o central mun.		Yes			Yes	
W/o urban mun.			Yes			Yes
Within $R^2$	0.471	0.468	0.470	0.281	0.284	0.283
Number of mun.	513	497	504	513	497	504
Observations	10260	9940	10080	10260	9940	10080

*Notes:* This table reproduces table 4 without tourism destinations. Tourism destinations are municipalities listed as resorts, health resorts, spas, coastal resorts, and coastal health resorts by the Statistical Office of Mecklenburg-Western Pomerania in 2015. Significance levels (standard errors robust to heteroskedasticity in brackets): \*\*\* 0.01, \*\* 0.05, \* 0.10.

Table A4: DD Regression – Pooled time dimension

	Property tax factor			Business tax factor		
	(1)	(2)	(3)	(4)	(5)	(6)
Access (<10 km)	6.196*** (2.18)	6.299** (2.52)	6.209*** (2.18)	2.215 (3.17)	3.048 (3.59)	2.159 (3.17)
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
W/o central mun.		Yes			Yes	
W/o urban mun.			Yes			Yes
Within $R^2$	0.443	0.441	0.443	0.271	0.274	0.273
Number of mun.	745	728	733	745	728	733
Observations	14900	14560	14660	14900	14560	14660

*Notes:* This table reproduces table 4 where the observations are pooled and the time dimension is ignored. Significance levels (standard errors robust to heteroskedasticity in brackets): \*\*\* 0.01, \*\* 0.05, \* 0.10.

Table A5: Summary statistics - Real estate offers

	Observations	Mean	SD
<i>Detached house</i>			
Price per $m^2$	150,187	1,112.68	695.35
Number of rooms	150,187	4.52	2.05
Area in $m^2$	150,187	140.03	65.95
<i>Apartment building</i>			
Price per $m^2$	9,708	714.31	578.39
Number of rooms	9,708	8.46	8.38
Area in $m^2$	9,708	357.28	369.10
<i>Condominium</i>			
Price per $m^2$	73,723	1,882.80	1,220.50
Number of rooms	73,723	2.93	1.75
Area in $m^2$	73,723	87.03	60.28
<i>Commercial property</i>			
Price per $m^2$	16,472	1,096.77	945.71
Number of rooms	16,472	4.00	6.35
Area in $m^2$	16,472	554.50	1,716.45

*Notes:* The observation units are the real estate properties offered for sale in the municipalities of the German state of Mecklenburg-Western Pomerania. We use data in levels during the period 2005 to 2015. For data protection reasons, we cannot show the minimum and maximum values of the variables.