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Beiträge der Dissertation im Überblick

Kapitel 2:

The Economic Impact of Schools for Local Labor Markets

Koautoren: Prof. Dr. Ronny Freier, Dr. Martin Simmler

Kapitel 3:

Firm Foundation and Location Choices - The Effects of Public Good and Service Provision

Koautoren: Prof. Dr. Nadine Riedel, Dr. Martin Simmler

Kapitel 4:

Firm Foundation and Localization Economies - The Sensitivity to Taxation and Public Good and Service Provision

Kapitel 5:

Do Political Parties Matter? - Evidence from German Municipalities

Koautoren: Prof. Dr. Nadine Riedel, Dr. Martin Simmler

The Effects of Public Inputs, Goods and Services on Households' and Firms' Location Decision

by

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Chapter 1

Preface

I. Purpose and Contribution

The economic literature discusses the effects of spatial economics ever since von Thünen's (1826) famous work. Most recently, since Krugman's (1991) work on "new economic geography" economists have started to incorporate a spatial dimension into their theoretical models and empirical analyses (see Fujita 2010, for a discussion). A spatial dimension enables economists to seek answers for the questions: Where do economic agents locate and what are the determinants of the decision?

The aim of this dissertation is to contribute to the discussion with an empirical analysis of households' and firms' location decision. As "spatial mobility provides the local public-goods counterpart to the private market's shopping trip" (Tiebout 1956, p. 422), this work will contribute with a detailed empirical analysis of the effects of public inputs, goods and services (PIGS). In his seminal work Tiebout (1956) discusses the effect of households mobility on the optimal provision of public goods. In a nutshell, while the private market solution generates an inefficient provision of public goods by one locality due to free-riding of individuals (Samuelson 1954), fully mobile households and an infinite set of competing localities will generate welfare improvements if utility maximizing households choose a locality with a fixed revenue-expenditure pattern that fit their preferences. Note that while the discussion on the implications of the Tiebout (1956) model concentrate on mobile households, the effects of PIGS on firms are less analyzed (Oates 2006). In addition, the solution for the Tiebout (1956) model is based on the assumption of inter-jurisdictional competition which has been tested in multiple contributions. Case *et al.* (1993), Baicker (2005), Solé-Ollé (2006) and Devereux *et al.* (2008) estimate reaction functions for government behavior and find evidence which is consistent with localities competing for mobile agents. Simultaneously, surprisingly scarce work on the assessment whether and to what extent jurisdictions can reduce their exposure to competition by specializing their public goods provision exist (see Bucovetsky 2005 and Justman *et al.* 2005 for notable work). In addition, only few detailed discussions on the effects of specialized PIGS on households' and firms' location decision exist.

The effects of PIGS on households' and firms' location decision are complex and multifaceted. This work will contribute to the debate providing greater insights on the empirical effects of PIGS on spatial mobility using detailed data for Germany. To do so, the discussion is split into four essays that analyze different isolated aspects of the process with the ultimate goal to dissect the individual effects. The joint of these effects should generate a better understanding of the overall effect.

Chapter 2 analyzes the effect of public goods (namely higher education schools) on households' location decision. Ever since Marshall (1890) the economic literature has theorized that agglomeration creates incentives for mobile capital to seek closeness to benefit from (1) localization economies (Marshall 1890, Arrow 1962, Romer 1986) and/or (2) urbanization economies (Jacobs 1969). Localization economies increase productivity of firms with increasing size of an industry in a geographical location, as spillovers (see e.g. Audretsch and Feldman 1996, for knowledge spillovers for R&D activities) are more likely. In contrast, urbanization economies increase productivity of firms with increasing size of all firms in a region, e.g. due to cheaper access to a larger qualified labor force (see Rosenthal and Strange 2004, for a discussion). Both, localization and urbanization economies, increase productivity (Rice *et al.* 2006, Graham 2007, Graham and Kim 2008) and thus wages (Melo *et al.* 2009) in urban regions. Ultimately, this will significantly increase the urban population in future years (United Nations, Department of Economic and Social Affairs 2014).

Although house prices can mitigate the trend in urbanization (Combes *et al.* 2012), the centralization of public goods in rural areas could re-enforce it. The cutback in the number of higher education schools in mid-sized towns and rural-areas in East Germany between 1990 and 2008 can be seen as an example for the relocation of public goods. The analysis will exploit the variation in the number of schools induced by the institutional change of the German reunification to test for the effects on employment, population and house prices. An assessment of these effects generates information on the importance of public goods for households' location choice.

The recent literature has seen many empirical contributions on firms' location decision (see e.g. Arauzo-Carod *et al.* 2010, for a survey). Chapters 3 and 4 will contribute to this flourishing literature. Most work concentrates on the effects of corporate taxation and the general results imply a negative effect on worldwide capital flows (see e.g. de Mooij and Ederveen 2003, Devereux *et al.* 2007, for surveys). Thus, low corporate tax rates create incentives to e.g. shift profits (Huizinga and Laeven 2008, Dharmapala and Riedel 2013) or to choose firm locations optimally subject to the tax burden. Simultaneously, referring to Fisher (1997), Sturm *et al.* (1998) and Romp and De Haan (2007) firms are also affected by PIGS provision at their location and via spillover or competition effects of neighboring locations (see Arauzo-Carod and Manjón-Antolín 2012, for a discussion of spatial effects). More importantly, large international companies might discount the negative effects of corporate taxation relative to the importance of PIGS provision (see e.g. Bénassy-Quéré *et al.* 2007). So far, the literature has found no consensus on the direction of these effects with some contributions pointing to positive and some to negative effects of PIGS provision (Fisher 1997). Two deficits of the literature should be highlighted. First, existing studies are mostly restricted to the macroeconomic level and lack appropriate indicators for the level of PIGS provision. Second, the results cannot be interpreted as causal as omitted variable bias or reverse causality biases the estimates. Lyytikäinen (2012) shows for tax rates that the latter can have serious consequences on policy implications. Both deficits will be addressed in this work.

In detail, chapter 3 quantifies the effects of PIGS provision on a spatial scale. This will address shortcomings of many existing empirical papers that are often restricted to the effects of PIGS in the providing locality assuming that no effects beyond the geographical limit exist (Solé-Ollé 2006, Arauzo-Carod and Manjón-Antolín 2012). Neglecting spatial effects can distort welfare consequences as PIGS provision creates positive or negative externalities that are not incorporated. If PIGS provision attracts mobile capital from neighboring localities the resulting provision would be inefficiently high as localities do not incorporate the negative external effect on their neighbors (Noiset 1995, Dhillon *et al.* 2007). Positive external effects will induce the opposite outcome if neighbors who benefit from PIGS provision act as free-riders, and thus making an underprovision of PIGS more likely (Wildasin 1991).

Chapter 4 will concentrate on the effects of localization economies on the sensitivity of firm foundations to taxation and PIGS provision. The recent economic literature has discussed the effects of agglomeration economies on the mobility of capital. Koh *et al.* (2013) demonstrate that capital mobility decreases with increasing agglomeration economies allowing locations to tax potential agglomeration rents. Moreover, in a recent contribution Brülhart *et al.* (2012) assess the sensitivity of firm foundations to changes of local corporate taxation in the presence of localization economies and find it to be diminished. So far, the effects of localization economies on the sensitivity of firms to PIGS provision remains an unanswered empirical question. This question is addressed using detailed data on PIGS expenditures and local business taxes in West Germany that are combined with a measure for localization based on work by Koh and Riedel (2014). An empirical setup that explicitly models the interacting effects of localization and PIGS provision (taxation) on the number of firm foundations generates a quantitative measure for the sensitivity of firms in strongly or weakly localized industries to changes in PIGS provision (taxation).

Lastly, chapter 5 will contribute to the literature on the determinants of public inputs, goods and services provision. Analyzing the effects of PIGS on agents' location decision in the previous chapters raises the questions about the level of public expenditures chosen by local governments. Tiebout (1956) assumes that the set of revenue-expenditure patterns are fixed for each locality and mobile individuals select based on their preferences by moving between localities. The theoretical assumptions of the model are hardly observed in practice as perfectly free individual mobility does not exist and the ability to "vote with the feet" is limited. Nevertheless, individuals vote for parties in democratic elections. Downs (1957) states that in a two-party system the winner of an electoral vote will be the party which political agenda aligns with the preferences of the median voter, and thus the political position of parties will shift towards the median until differences are absent. The absence of political partisanship was consensus among economists for a long period (Hotelling 1929, Downs 1957) although many empirical contributions to the literature found contradicting results. Besley and Case (2003) show for the U.S. that a higher fraction of Democrats in the state legislature is associated with significantly higher spending per capita. Moreover, Lee *et al.* (2004) show that party affiliation explains a great fraction of variation in voting behavior in Congressional voting. Potrafke (2011a) finds weak evidence for higher spending for public services by leftist-governments in OECD countries. Additionally, using a sample of German federal states Potrafke (2011b) finds evidence in favor of higher spending for schooling by leftist-governments and higher spending for universities and cultural affairs by right-wing governments. Taste-based models where political parties can not credibly commit to moderate policies (Alesina 1988, Besley and Coate 1997) or strategic voter targeting (Glaeser *et al.* 2005) provide explanations for the existence of partisan politics and have gained increased interest. Strikingly, the empirical literature on the local level is scarce. In a recent article Ferreira and Gyourko (2009) demonstrate that partisanship is absent in U.S. cities and that Democratic or Republican mayors do not affect the size of the government. They conclude that the local level significantly differs from the state and federal level such that, first, significant inter-jurisdictional mobility tends to create more homogeneous units diminishing the role of partisanship; second, competition of localities for mobile residents and capital may limit the size of partisan politics; third, a lack of adequate information channels for voters on the local level might prohibit politicians to communicate their partisan positions. In another article Freier and Odendahl (2015) empirically tests for the influence of parties on municipalities tax rates in Germany highlighting evidence in favor of partisanship.[1] Based on opposing theoretical predictions and empirical results it seems beneficial to add an empirical analysis of partisan politics in German municipalities with respect to PIGS provision.

II. Main Findings

Chapter 2 assess the short and long run impact of local grammar schools on employment in East German municipalities. It is joint work with Prof. Dr. Ronny Freier and Dr. Martin Simmler. Agglomeration economies increase productivity and create a trend of stronger urbanization. Stronger urbanization is on the one hand mitigated by adjusting house prices and on the other hand fortified by the centralization of public goods in rural areas. We derive a theoretical framework that predicts reactions of employment in a small village and a large town to changes in the provision of public goods.[2] People are either living and working in the same location (Workers) or commute between locations (Commuters). This is motivated by higher wages in the town due to higher agglomeration economies. However, commuting is costly and people value living in either the village or town. The latter will be captured in a (net) preference parameter for people living in the village. Additionally, people lose part of their preference for living in the village if they commute. We demonstrate that in the short-run changes in the provision of a public good in villages affects the number of workers only in villages that are characterized by high commuting costs and a low share of out-commuting inhabitants. This is based on the fact that in low commuting cost jurisdictions commuters are first responders.[3] If they leave the village adjustments in house prices are less sensitive to the loss of the public good

[1]Specifically, the data comprises council and mayoral elections in Bavaria.
[2]We assume that changes in the characteristics of the village have no impact on the town.
[3]Note that our model will demonstrate that commuters value living in the village less than workers.

and will compensate those who stay. Moreover, we show that the long-run effects on residential employment are equal in high- and low commuting cost jurisdictions if urbanization and production externalities are relevant. To quantify the short-run implications of changes in the provision of public goods we apply a Difference-in-Differences strategy on school closures in mid-sized towns between 1997 and 2008. We find evidence in favor of a 9% decrease in residential employment (those who work where they live) in locations with a low share of out-commuters if the only grammar school was closed. As proposed by our theoretical framework this effect is basically non-existing for locations with low commuting costs and a high share of out-commuters. On top, we demonstrate that the effect is increasing with time and estimate a reduction in residential employment around 16% after 4 years. Using house price data we identify a reduction of prices by 7% to 11% for both location types if the location lost its only grammar school. The results support our theoretical motivation. To estimate the long-run effects of grammar schools on local employment we apply an instrumental variable framework exploiting variation in historical institutions for higher education. Namely, we exploit information on the location of grammar schools in Prussia (in 1914) and cloisters between 1400 and 1500. If one (or both) existed in a jurisdiction this increased the likelihood of having a grammar school today. Furthermore, we exploit the fact that the German reunification in 1990 induced a unique institutional change in East Germany as the former GDR had to adopt the West German school system. Our empirical strategy estimates a 110% higher population and 70% higher house prices in municipalities with a grammar school in 2008 and high commuting costs. The effects in municipalities with low-commuting costs are 60% and 20% respectively. We don't find substantial differences between high- and low commuting cost jurisdiction when analyzing the effect on employment. Our point estimates predict a between 100% and 140% higher employment in municipalities with a grammar school in 2008 compared to municipalities with none. On top, our estimates allow us to quantify the elasticities of urbanization and production externalities. The first is represented by the change in utility of residents and the second by the change of wages. We calculate that wages increase by 0.62 to 0.68 for a marginal change in the number of workers and an increase in the population increases utility of residents by 0.76 to 0.88. Our work allows us to contribute to the debate on the effects of PIGS on shaping agglomeration economies. The results suggest that e.g. grammar schools and thus public goods can play a substantial role for the spatial distribution of people and employment. More importantly, we demonstrate that increasing centralization of public goods in rural areas fortifies the trend in urbanization.

Chapter 3 is joint work with Prof. Dr. Nadine Riedel and Dr. Martin Simmler and determines the effect of PIGS provision on firm foundation and location choices. We propose a theoretical model of firm foundations and location choices where firms with a location bliss point on a unit interval have to choose among two municipalities (A and B) that are characterized by corporate taxation and the provision of PIGS to maximize profits after mobility costs. First, the model depicts that there exists a cutoff bliss point for firms locating in municipality A that will shift closer to A if the municipality increases its own corporate tax rate. Thus, with increasing taxation the attractiveness decreases and fewer firms are willing to locate in this municipality. Second, based on the latter an increase in corporate taxation of municipality A increases the number of firms locating in B due to the shift in the cutoff bliss point. Third, PIGS provision by one municipality will increase its attractiveness for firms if PIGS are beneficial for productivity. Fourth, PIGS provision by A has an ambiguous effect on firms in the other municipality B. On the one hand, competition leads to a shift of the cutoff bliss point of firms that are willing to locate in municipality B closer to its centroid such that fewer firms are willing to locate there. On the other hand, firms located in B benefit from spillover effects of A's PIGS provision which has a positive effect on the number of firms willing to locate in B. We test the implications of our theoretical model using data on the number of firm foundations in West Germany between 1998 and 2006. The data is combined with unique information on municipalities PIGS provision, local business tax rates and socio-economic controls. We use a Poisson model and incorporate spatially lagged variables to assess the effects of neighbors PIGS provision and taxation on firm foundations. As predicted by our theoretical model we identify a negative effect of taxation and a positive effect of PIGS provision in the considered municipality. On top, the effect of an increase in neighbors tax rate is positive and in favor of competition effects between municipalities. Our results support the notion of spillover effects of overall PIGS provision between close neighbors (within 15km to 20km). On top, our sample allows us to analyze the effects of various PIGS categories on different industries. We do find a positive and significant effect of people goods (e.g. child- and youth care or schools) on firms in industries with many employees aged 35 to 49. Moreover, we do find evidence for competition effects between neighboring municipalities with respect to the provision of people goods.

Chapter 4 contributes to the previous chapter analyzing the sensitivity of firm foundations to changes in local taxation and PIGS provision when firms benefit from localization economies. As has been outlined before localization economies benefits firms in the same industry and location. I assume that firms location decision is solely based on location characteristics. While it is a well-established fact that higher corporate taxes reduce the attractiveness of locations (see e.g. de Mooij and Ederveen 2003, Devereux *et al.* 2007, for surveys) recent contributions to the literature discuss the effects of localization economies on firms sensitivity to tax changes (see e.g. Kind *et al.* 2000, Ludema and Wooton 2000, Andersson and Forslid 2003, Baldwin and Krugman 2004, Borck and Pflüger 2006, Baldwin and Okubo 2009). Following a recent discussion by Brülhart *et al.* (2012) I review the results using data on firm foundations and tax rates in West German municipalities. On top, while the former chapter depicts increasing attractiveness of locations with increasing provision of PIGS, localization economies might affect the sensitivity of industries to changes in the PIGS provision. In line with the literature the results support the assumption that increasing localization decreases the sensitivity of firm foundations to changes of the local business tax. While an increase of the average tax rate by 1% decreases the expected number of firm foundations by around 4.4% in weakly localized industries, the expected number of firm foundations in strongly localized industries decreases by 1.34%. Moreover, a 1% increase in the average capital stock of economic promotion increases the expected number of firm foundations in weakly localized industries by 0.13% and in strongly localized industries by 0.08%. To sum up, the results show that localization economies reduce the sensitivity of firm foundations to changes in location characteristics. These results contribute to the ongoing discussion on strategic tax setting of governments. In addition, the results imply that localization creates possibilities for municipalities to tax agglomerations rents as discussed by Koh *et al.* (2013).

The last chapter analyzes the existence of partisan politics on the local level in West Germany. It is joint work with Prof. Dr. Nadine Riedel and Dr. Martin Simmler. While there is substantial evidence for the existence of partisan politics on higher governmental levels (e.g. the state or federal level) recent work suggests that it may be absent on the local level. We use detailed data on the spending composition of West German municipalities and link it to election data for local councils and mayors. Using three different estimation frameworks (Fixed Effects Regression, Regression Discontinuity Design and Instrumental Variable Regression) we do find evidence for mild partisan politics at best. In summary, using a Regression Discontinuity Design for mayors who won in close elections we identify significant but weak differences in expenditure shares for PIGS in left- and right-wing governed municipalities. These results are supported using fixed effects regressions that resemble a Difference-in-Differences framework for mayors and local councils. On top, we use an Instrumental Variable Regression to assess the effect of unexpected revenue shock on municipalities spending decisions. The idea is that municipalities who get unanticipated revenues can use unexpected additional revenues for partisan politics. The results do not point to significant partisan effects at the local level.

Combining the chapters draws a more conclusive picture on the level of PIGS provision in German municipalities and its effects on households' and firms' location decision.

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Chapter 2

The Economic Impact of Schools for Local Labor Markets

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Abstract

This papers assesses the short run and long run impact of local grammar schools on employment. Applying a difference-in-differences strategy on school closure in mid-sized towns in East Germany between 1997 and 2008 we find that grammar school closures reduce employment by about 16% (after 4 years) if the share of out-commuters in a jurisdiction is small. We identify the long run effect, which is with 146% substantially larger, by implementing an instrumental variable strategy using historical information on higher education institutes. Although commuting cost differences do not influence the long run employment effect, they predict whether the increase in employment is driven by an inflow of workers or less out-commuting. In addition, we use our estimates to quantify the importance of residential and production externalities for shaping agglomeration economies.

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I. Introduction

The UN estimates that in 2050 almost 70% of the world population will live in urban areas, up from 30% in 1950 (UN 2014, World Urbanization Prospects - The 2014 Revision). The driving force behind this trend is seen in agglomeration economies which increase productivity (Rice *et al.* 2006, Graham 2007, Graham and Kim 2008) and thus wages (see e.g. Melo *et al.* 2009) as well as urban amenities (Ahlfeldt *et al.* 2015) in cities. While adjusting house prices mitigate the trend in urbanization (see e.g. Combes *et al.* 2012), the centralization of public goods in rural areas - as a response to the decline in the population density - may re-enforce the urbanization trend. Our paper tests this presumption by investigating the role of local availability of grammar schools for local employment in mid-sized towns in East Germany. Following recent literature (see e.g. Monte *et al.* 2017), we pay particular attention to differences in commuting patterns between jurisdictions when analyzing the employment effects. Commuting goes hand in hand with urbanization as agglomeration economies capitalize into housing prices and thus increase the incentive to commute to cities. Further, by investigating the short run as well as the long run impact of local availability of grammar schools, we are also able to quantify the importance of residential and production externalities in shaping agglomeration economies.

Our paper starts by setting out a stylized theoretical model of local employment in a (small) village and a (large) town. Village and town differ with respect to a locally provided public good and a non-publicly provided amenity. All residents value the public good to the same extend but differ in the valuation of the amenities. Commuting is allowed and comes at fixed costs as well as a reduction in the valuation of the amenity. This is motivated as commuters spend part of their day commuting. Labor demand is given by a competitive firm sector in the town and village. We assume constant returns to scale in the town and village but allow total factor productivity to be jurisdiction specific. Agglomeration economies are modeled along two dimensions: (1) we capture production externalities by assuming total factor productivity to be a non-decreasing function of the number of workers in the jurisdiction; (2) we account for residential externalities by introducing a second amenity which is a non-decreasing function of the number of residents in the jurisdiction.

Based on our theoretical model we predict the short run as well as the long run impact of a change in the locally provided public good on residential employment and population. For the short run, in which we assume agglomeration economies to be non-important, our model predicts that a decrease in the level of public goods affects only local employment if the share of out-commuters is small. The reason is that out-commuters are marginal inhabitants due to the loss in preferences when commuting. Thus, if the out-commuter share in a jurisdiction is sufficiently large, the outflow of commuters decreases house prices sufficiently such that utility of local workers is unchanged. As a result they do not respond. However, population and thus house prices should change similar. The long run effect on local employment depends on the strength of residential and production externalities. If both are present, employment changes in jurisdictions with high and low commuting costs.

We test the theoretical predictions using the local availability of grammar schools in mid-sized towns in East Germany between 1990 and 2008. To assess the short run impact of local grammar schools, we employ a difference-in-differences design using grammar school closures after 2000. These were caused by a substantial outflow of people to West Germany and a drop in birthrates due to economic uncertainty after the re-unification as well as a wave of migration from rural to urban areas in the second half of the 90s. To lessen concerns about school size, we focus on jurisdictions with only one grammar school that was closed during our sample period and compare these jurisdictions to similar sized jurisdictions in which the only grammar school continued to exist. For the average jurisdiction with a school closure we do not find evidence for a reduction in employment. Splitting the sample according to the share of out-commuters or the cost of commuting (proxied by the distance to the next highway or railway) we identify clear evidence in line with our theoretical predictions. In jurisdictions with a high share of out-commuters we do not find any employment effects. Contrasting, in jurisdiction with a low share of out-commuters employment is reduced by 9% on average or 16% after four years. To address whether differences in preferences for grammar schools between treatment and control group explain our results, we investigate the incidence of school closures into house prices. Using micro-level offer data from 2004 to 2008 we identify a drop in house prices in all jurisdictions with a school closure around 11%. This suggests similar preference for grammar schools in jurisdictions with a high and a low share of commuters. Further, an absolute drop in house prices of about 13.000 Euro is reasonable as it suggests commuting costs per hour of around 10 Euro (based on the fact that pupils have to go to school for on average 200 days for 8 years and that the school closure leads to additional commuting of 1 hour per school day).

To assess the long run impact of the local availability of grammar schools on employment, we exploit the German re-unification as a quasi-natural experiment similar to von Ehrlich and Seidel (2015) and Redding *et al.* (2011). Since grammar schools were less important in the German Democratic Republic (GDR), the re-unification led to the opening of grammar schools in several jurisdictions in East Germany. Potential omitted variable bias due, for example, political governance is addressed by implementing an instrumental variable strategy. We use two sets of instruments that exploit information on historical higher education schools similar to Moeller and Zierer (2018). The first is the presence of a higher education institute in the jurisdiction at the beginning of the 20th century (1914).[1] The second exploits the presence of a cloister within the jurisdiction between 1400 and 1500. This is motivated as during this time in particular cloisters opened their doors for the education of the public. Since historical higher education institutes are likely to have been critical for the formation of agglomeration economies, we include a wide range of variables to capture these at the time of the re-unification. Based on this approach, we estimate the long run (18 years) impact of the local availability of grammar schools on local employment to be in the order of 146%. When splitting the sample according to the costs of commuting in a jurisdiction, we find no differences in the employment effect in the two sub-samples but a remarkable difference in the

[1] Specifically, we use historical information on the presence of higher education schools in Prussia.

change in population. These effects are in line with our theoretical model and the presence of residential as well as production externalities. In low-commuting cost jurisdictions the employment effect is strongly driven by less out-commuting and in high-commuting cost jurisdictions by an inflow of workers. Further, we find consistent house price changes which mirror the population changes and thus are larger in high-commuting cost jurisdictions.

In the last part of the paper, we use our model and the empirical estimates to quantify the importance of residential and production externalities. Similar to the results by Melo *et al.* (2009) we calculate that wages increase by 0.62 to 0.68 for a marginal change in the number of workers. On top, an increase in the population increases utility of residents by 0.76 to 0.88.

Our analysis contributes to several streams of literature: First, we add to the literature that investigates the role of public good provision on local employment. Despite it's high relevance for local governments, the literature has so far mainly focused on the impact of "firm" public goods such as universities (Bania *et al.* 1993) or infrastructure (Redding *et al.* 2011, Duranton and Turner 2012, Moeller and Zierer 2018) on firm location and firm performance or on the impact of "people" public goods such as schools on individuals' location decision (Buettner and Janeba 2016, Albouy and Lue 2015). While it is indisputable that firms employ people and thus have a direct impact on employment in localities, decisions on the size of university funding or large infrastructure projects are usually not in the hand of the local government. Further, it is not obvious whether attracting people does lead to more local employment or whether attracted people simply out-commute. Most closely related to our work are thus studies that focus on "people" public goods and/or local employment as Mofidi and Stone (1990), Dalenberg and Partridge (1995) and Gabe and Bell (2004).

Mofidi and Stone (1990) assess the impact of educational spending on manufacturing employment on the state level in the U.S. between 1962 and 1982 and find a positive impact. Furthermore, Dalenberg and Partridge (1995) study employment in 28 metropolitan areas between 1966 and 1981 and find a positive impact of educational spending as well. Gabe and Bell (2004) distinguish between different types of educational spending on the municipality level and identify for some spending categories such as school transport or administration negative and for others such as the availability of schools that offer education to the twelfth grade a positive impact on the number of businesses that locate in a particular municipality using data between 1993 and 1995 in Maine (USA). The impact is, however, mainly identified within counties as there is not sufficient variation over time. We contribute to this literature by examining the short and long run impact of local educational spending on employment. On top, our sample exploits variation over time when identifying the short run impact and thus reduces concerns about omitted variables.

Second, we add to the literature on local labor markets (for a review of the literature see Moretti 2011). In a recent contribution Monte *et al.* (2017) highlight the role of commuting differences between jurisdictions for observed local employment elasticities. In particular, the authors show that employment effects in response to labor demand shocks are increasing with jurisdictions' commuting openness as moving people is more costly than moving goods. Their main measure of commuting openness is the share of residents who work where they live, which mirrors our measure.[2] Our work differs from their work in such that we investigate changes in a publicly provided good which affects utility of residents within a jurisdiction but not the utility of in-commuters. In contrast, wage shocks affect all workers within a jurisdiction but not out-commuters. Further, our theoretical framework is much simpler in many ways. Most important, it does not account for cross-commuting. Although in our and their work, the commuting share is a proxy for commuting costs, it is key for our predictions that out-commuters, if existent, are marginal inhabitants and thus may absorb positive as well as negative public good shocks completely.

Lastly, we contribute to the literature that investigates whether schools and school quality capitalizes into house prices. Recent contributions to the literature support

[2]We define the share of out-commuters as the share of residents who *do not* work where they live.

a capitalization into house prices (see e.g. Black and Machin 2011). In contrast to most work, while the reasonableness of the estimates for school quality are hard to judge, our approach, which relies on the availability of local grammar school, has the advantage that it allows us to assess the plausibility of our estimates.

The remainder of this article is structured as follows. In Section II, we present the institutional settings necessary to understand our research approach. Section III sets out a stylized theoretical model to motivate our empirical analysis. The empirical strategies, the data and our results are presented in sections IV and V. Section VI concludes.

II. Institutional Background

In the following we describe the two (main) sources of variation in the local availability of grammar schools in mid-sized towns in East Germany between 1990 and 2008. Thereafter, we briefly describe the responsibilities for schools in Germany.

The first part of variation in the availability of grammar schools in East Germany stems from the German re-unification on October 3rd 1990 and the adoption of the West German school system. Grammar schools were substantially less important in the GDR, which can be highlighted along the following margins. First, all children in the GDR went to a common school (*Polytechnische Oberschule*) until age 15/16. Part of the pupils then continued education for additional two years at a higher secondary school which ended with a university entrance diploma (*Erweiterte Oberschule*). In West Germany as well as in East Germany after 1990, pupils only attended a common elementary school until age 10/12 (depending on the state). Then, for between 6 and 9 years pupils were tracked into different school types. In general, there are three main types of schools, which can be distinguished by the level of academic ambitions and quality of education. These are grammar schools (*Gymnasium*) as the highest quality school, other secondary modern schools (*Realschule, Gesamtschule, Oberschule*) or basic secondary schools (*Hauptschule*).

The *Gymnasium*, to which pupils go between 8 and 9 years is the only school that provides a regular path to obtain a university-entrance diploma.[3]

The less important role of grammar schools in the GDR is not only evident with respect to the years of schooling they provide but even more when comparing the share of pupils leaving grammar schools or leaving school with a university-entrance diploma in West and East Germany in 1990. While the share of pupils leaving school with a university-entrance degree was 33.5% in West Germany (or 24.4% leaving grammar school), the share was only 13.3% in East Germany (or 8.8% leaving grammar school).[4] Further, the share in East Germany after 1990 did not only increase to the West level but increased even further. In 2014, on average 41% of pupils went to grammar schools and almost 52% of pupils leaving school had a university-entrance degree.[5].

Lastly, the substantial difference in the availability of grammar schools before and after the German re-unification is also reflected in the number of jurisdictions with a grammar school. Half of the roughly 250 jurisdictions with one grammar school today had no grammar school before 1990. Simultaneously, only 25 jurisdictions that had a grammar school before 1990 have none today.

The second part of variation in the availability of local grammar schools in East Germany relates to changes in the spatial distribution of inhabitants after 1990. These occurred due to three reasons. First, the re-unification triggered a massive migration wave from East to West Germany. Overall, about four million (out of 16 million) moved to West Germany for at least some time. As it was mostly the younger people moving, this had direct effects on the number of pupils attending East German schools. Second, the reunification also triggered a wave of migration from rural to urban areas. Saxony-Anhalt, a mostly rural area saw its population decrease by more than 20% from 1993-2013 (after the initial east-west migration)

[3]Note that good students at the other schools may have the chance to switch schools after a number of years and move up to a *Gymnasium*. In some states, different school tracks are offered within one school (*Gesamtschule*).

[4]`http://www.bildung-weltweit.de/pdf/kurzdarstellung_deutschland.pdf`

[5]`https://www.destatis.de/DE/Publikationen/Thematisch/BildungForschungKultur/Schulen/BroschuereSchulenBlick0110018169004.pdf?__blob=publicationFile`

and had to close about 60% of all schools in rural areas during the process. Finally, East Germany experienced a massive drop in child births when families postponed the fertility decision due to economic uncertainty after the reunification (Chevalier and Marie 2013). Estimates of the fertility gap in the early 90s show that birth rates dropped by half and stayed significantly lower ever since. This implies that 6 years later, elementary schools saw a large drop in the number of pupils and ten years later the number of students for higher secondary schools was declining.

The decision about school openings as well as closures is made jointly by the parties involved in running a (public) school in Germany. These are the federal state, the county as well as the hosting municipality. States do, however, have the final say as they are bearing the main burden and are in particular responsible for hiring and overseeing teachers as well as providing general funds per student. Counties, in contrast, are usually responsible for pupil transportation, youth welfare services and schools for children with special needs. Municipalities are in charge of the school infrastructure and maintaining school buildings, facilities and equipment.

Not surprisingly, neither openings nor closures are happening over night. In the data, we assign openings and closings to the year of the actual school opening and closing. Anecdotal evidence and interviews with municipality administrations suggest that the announcement for closure is, however, usually done two years in advance.

III. Theoretical Motivation

In the following section, we present a stylized theoretical model which motivates our empirical analysis. We start describing the model without consideration of agglomeration forces. We believe that this is a reasonable approximation of the short run dynamics. Thereafter, we introduce residential as well as production externalities similar to Ahlfeldt *et al.* (2015) to model the long run dynamics.

There are two jurisdictions, a small village (v) and a large town (t).[6] Further, there

[6] We denote the residential population of the village or town by P_j.

are workers who supply one unit of labor. They either live in the village or in the town and either work in the village or in the town. Town and village differ with respect to wages (w), a locally provided (pure) public good (g), a non-publicly provided amenity (a) and house prices (h). To simplify the analysis, we assume the village to be relatively small such that changes in the village do not affect the town.

While each worker values the public goods to the same extent ($v(g)$) which is an increasing function in the amount of provided public goods ($\frac{\partial v(g)}{\partial g} > 0$), workers differ in the valuation of the amenity. For simplicity, we summarize the difference in the valuation of the amenities in town and village in a preference parameter for living in the village (η). We assume that preferences are uniformly distributed, with lower $\underline{\eta}$ and upper $\overline{\eta}$ bounds and normalize the range to one.

In both jurisdictions many firms exist which produce a tradeable good (with zero transport costs) for which the price is normalized to one. The only input in the production function is labor and the production function has constant returns to scale. The production function differs between town and village due to a jurisdiction specific total factor productivity (A). Wages in the town and in the village are thus given by

$$w_j = A_j \tag{2.1}$$

with $j = t, v$. We assume that wages are higher in the town ($A_t > A_v$).

House prices (h_j) in town and village are determined by housing supply and demand. Demand is given by the number of residents in the jurisdiction. In the short run, we assume housing supply to be fixed. In the long run, housing supply adjustment may occur and thereby decreasing the housing price increase for a marginal change in the jurisdictions' population. If housing supply adjusts perfectly, e.g. if there are no land restrictions, house prices at the periphery of the jurisdiction equal the return from the alternative use of land. The latter may differ between jurisdictions due to land quality differences. Without loss of generality we assume that within-jurisdiction commuting costs are zero and thus that house prices are constant within each jurisdiction.

If workers live in the village (town) but work in the town (village), we refer to them as out-commuters. Commuting affects workers' utility in two ways. First, there are fixed costs of commuting (c).[7]. Second, since commuters spend part of the day commuting, they loose α of their living preference η.

The utility of worker i in one of the two jurisdictions is given by equation (2.2) and utility of commuter i (if existent) in one of the two jurisdictions is given by equation (2.3), with $j = t, v$ and D as indicator variable:

$$U_{i,j,j} = w_j - h_j + v(g_j) + D(j = v)\eta_i \tag{2.2}$$

$$U_{i,j,k} = w_k - c - h_j + v(g_j) + D(j = v)(1 - \alpha)\eta_i \tag{2.3}$$

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Short-run dynamics

Utility maximization of each worker yields the equilibrium for this model, which is defined by the number of workers and the number of out-commuters in the village. We solve the model by providing first an expression for the number of workers and commuters in the village and then analyzing how a change in the locally provided public good affects the number of workers and commuters in the village.

For each potential worker in the village two conditions need to be met. First, utility of living and working in the village ($U_{i,v,v}$) needs to be larger or equal to living and working in the town ($U_{i,t,t}$). Second, utility of living and working in the village needs to be larger or equal to living in the village and working in the town ($U_{i,v,t}$). Rearranging the first condition provides an expression for the minimum preference for living in the village (η^w_{min1}) among all potential workers compared to workers in the town (equation (2.4)). It states that the minimum preference among all potential workers in the village equals the sum of wage, housing price

[7]Commuting is for example only possible between the town center and the village center.

and public good differential. Rearranging the second condition gives the minimum living preference among all workers compared to commuters η^w_{min2} (equation (2.5)). Since it is not clear whether the marginal inhabitant in the village is a worker or a commuter, the minimum living preference among all workers in the village is given by the maximum of η^w_{min1} and η^w_{min2}.

$$\eta^w_{min1} = (w_t - w_v) - (h_t - h_v) + (v(g_t) - v(g_v)) \tag{2.4}$$

$$\eta^w_{min2} = \frac{1}{\alpha}(w_t - w_v - c) \tag{2.5}$$

For out-commuters in the village two similar conditions have to be fulfilled. For them utility of being a commuter ($U_{i,v,t}$) needs to be larger than being a worker in the village ($U_{i,v,v}$). This is equivalent to the second condition for the workers (see equations (2.5) and (2.6)). From the perspective of the commuters, this gives the maximum living preference among all commuters in the village. The second condition states that utility of commuters in the village must be larger or equal to the utility of being a worker in the town ($U_{i,t,t}$). This can be re-arranged to derive an expression for the minimum living preference among all commuters in the village (see equation (2.7)).

$$\eta^c_{max} = \eta^w_{min2} = \frac{1}{\alpha}(w_t - w_v - c) \tag{2.6}$$

$$\eta^c_{min} = \frac{1}{1-\alpha}(-(h_t - h_v) + (v(g_t) - v(g_v)) + c) \tag{2.7}$$

$$\begin{aligned} \eta^c_{max} > \eta^c_{min} : \frac{1}{\alpha}(w_t - w_v - c) &> \frac{1}{1-\alpha}(-(h_t - h_v) + (v(g_t) - v(g_v)) + c) \\ \Rightarrow c &< (w_t - w_v) - \alpha\,(\eta^w_{min1}) \end{aligned} \tag{2.8}$$

Comparing maximum and minimum living preference of commuters in equation (2.8) shows that there will be only commuters if the benefit from working in the town

Table 2.1: Summary Equilibrium Values for Workers, Commuters and Population in the Village

Out-commuters	> 0	$= 0$
Workers (W)	$W^{LC} = \overline{\eta} - \eta^{w}_{min2}$	$W^{HC} = \overline{\eta} - \eta^{w}_{min1}$
Out-commuters (C)	$C^{LC} = \eta^{c}_{max} - \eta^{c}_{min}$	$C^{HC} = 0$
Population (P)	$P^{LC} = \overline{\eta} - \eta^{c}_{min}$	$P^{HC} = \overline{\eta} - \eta^{w}_{min1}$

(e.g. due to higher wage) reduced by the adjusted minimum living preference for working and living in the village exceeds commuting costs. The smaller the loss in preferences due to commuting (the smaller α), the less important the residential benefits and the costs of commuting. The idea behind that is a smaller loss in living preference means a relatively higher weight of the living preference in commuters' utility and thus a smaller weight of living differences and commuting costs. Using the assumed uniform distribution of η, we can derive expressions for the number of commuters and workers in the village (see Table (2.1)).

This allows us to derive the impact of a marginal increase in the level of public goods in the village. We start with the case of no commuters in the village.[8] Taking the total derivative of the number of workers (W^{HC}) with respect to the locally provided public good in the village (g_v) shows after re-arranging that the number of workers increases since people value public goods ($\frac{\partial v(g_v)}{\partial g_v} > 0$) and house prices are a non-decreasing function of the number of residents ($\frac{\partial h_v}{\partial P^{HC}} = \frac{\partial h_v}{\partial W^{HC}} \geq 0$) (see equation (2.9)).

$$\frac{\partial W^{HC}}{\partial g_v} = \frac{\frac{\partial v(g_v)}{\partial g_v}}{\left(1 + \frac{\partial h_v}{\partial W^{HC}}\right)} \tag{2.9}$$

We turn to the case where commuters are present in the village. It can be shown that the number of workers W^{LC} does not change as the number of workers depends only on the wage differential and commuting costs (see equation (2.10)).

$$\frac{\partial W^{LC}}{\partial g_v} = 0 \tag{2.10}$$

[8] We ignore in the following the transition between the two possible states as this doesn't affect the general predictions of the model.

$$\frac{\partial C}{\partial g_v} = \frac{\frac{1}{(1-\alpha)}\frac{\partial v(g_v)}{\partial g_v}}{\left(1 + \frac{1}{(1-\alpha)}\frac{\partial h_v}{\partial C}\right)} \tag{2.11}$$

Thus, in this case only the number of commuters (C) increases. For workers this effect is stronger the more individuals value public goods and the smaller the increase in house prices (see equation (2.11)). However, it also depends on the loss in living preference of commuters. If the loss is small, which we assume to be a realistic assumption, the number of workers in the jurisdiction with no out-commuters and the number of commuters changes to the same extend and thus also house prices would chance equally (if housing supply adjustments are similar as well).

Long-run dynamics

We now turn to the long run equilibrium in which we account for both dimensions of agglomeration externalities, (1) residential and (2) production externalities. To include production externalities we assume that jurisdictions' total factor productivity (A) and thus the wage (w) is a non-decreasing function of the number of workers. Residential externalities are included following the approach by Ahlfeldt *et al.* (2015). Thus, we add a second amenity in workers' and commuters' utility function (see equation (2.12) and (2.13)) which is a non-decreasing function of the number of residents in the jurisdictions. The idea is that more residents increase a jurisdictions' attractiveness as, for example, cultural events are more likely to take place the larger the potential audience.[9] For simplification, we assume that all workers value the second amenity to the same extent and capture the difference in the second amenity in the net-amenity value in the village (b).

$$U_{i,j,j} = w_j - h_j + v(g_j) + D(j = v)[\eta_i + b] \tag{2.12}$$

[9]This is also likely to hold for bars, restaurants or supermarkets, and could in principle also be modeled like this. However, we believe that the way of Ahlfeldt *et al.* (2015) is simpler without changing the implications and thus preferable.

$$U_{i,j,k} = w_k - c - h_j + v(g_j) + D(j = v)(1 - \alpha)[\eta_i + b] \tag{2.13}$$

.

This changes the minimum living preference among all workers (see equation (2.14) and (2.15)) and the minimum as well as the maximum living preference among all commuters (see equation (2.15) and (2.16)). Not surprisingly, a higher second amenity reduces the minimum living preference among workers as well as minimum and maximum living preference among commuters.

$$\eta^w_{min1} = (w_t - w_v) - (h_t - h_v) + (v(g_t) - v(g_v)) - b \tag{2.14}$$

$$\eta^w_{min2} = \eta^c_{max} = \frac{1}{\alpha}(w_t - w_v - c) - b \tag{2.15}$$

$$\eta^c_{min} = \frac{1}{1-\alpha}(-(h_t - h_v) + (v(g_t) - v(g_v)) - c) - b \tag{2.16}$$

In the following we present the long run implications of our model. We start with the impact of the local availability of grammar schools on the population in jurisdictions with no out-commuters (using the fact that in jurisdictions without commuters employment equals population). The total derivative is given by:

$$\frac{\partial P^{HC}}{\partial g_v} = \frac{\frac{\partial v(g_v)}{\partial g_v}}{\left(1 - \frac{\partial w_v}{\partial W^{HC}} + \frac{\partial h_v}{\partial P^{HC}} - \frac{\partial b}{\partial P^{HC}}\right)} \tag{2.17}$$

For the jurisdiction with out-commuters it is given by:

$$\frac{\partial P^{LC}}{\partial g_v} = \frac{\frac{1}{(1-\alpha)}\frac{\partial v(g_v)}{\partial g_v}}{\left(1 + \frac{1}{(1-\alpha)}\frac{\partial h_v}{\partial P^{LC}} - \frac{\partial b}{\partial P^{LC}}\right)} \tag{2.18}$$

In both cases, population increases because people value public goods. The increase is stronger the more people value public goods, the less strong the increase in house prices and the stronger the impact of population on amenity. Further, the population increase is larger in the case of no out-commuters as wages increase with the number of workers (under the assumption that α is close to 0). If production externalities are absent, population in high- and low-commuting cost jurisdictions increases to the same extent.

We turn to the prediction for the number of workers. In the case of no out-commuters, the change in the number of workers equals the change in the population. For the other case, the total derivative is given by equation (2.19). It states that the number of workers depend on the marginal change of production as well as marginal change in residential externalities. If we replace the change in population due to the public good change ($\frac{\partial P}{\partial g_v}$), we see that the change in public goods triggers an inflow of out-commuters which stimulate employment due to residential externalities. This impact is then exaggerated by production externalities.

$$\frac{\partial W^{LC}}{\partial g_v} = \frac{\frac{\partial b}{\partial P^{LC}} \frac{\partial P^{LC}}{\partial g_v}}{\left(1 - \frac{\partial w_v}{\partial W^{LC}}\right)} = \frac{\frac{\partial b}{\partial P^{LC}} \left(\frac{\frac{1}{(1-\alpha)} \frac{\partial v(g_v)}{\partial g_v}}{\left(1 + \frac{1}{(1-\alpha)} \frac{\partial h_v}{\partial P^{LC}} - \frac{\partial b}{\partial P^{LC}}\right)} \right)}{\left(1 - \frac{\partial w_v}{\partial W^{LC}}\right)} \tag{2.19}$$

$$\frac{\partial W^{HC}}{\partial g_v} = \frac{\partial P^{HC}}{\partial g_v} = \frac{\frac{\frac{\partial v(g_v)}{\partial g_v}}{\left(1 + \frac{\partial h_v}{\partial P^{HC}} - \frac{\partial b}{\partial P^{HC}}\right)}}{\left(1 - \frac{\frac{\partial w_v}{\partial W^{HC}}}{\left(1 + \frac{\partial h_v}{\partial P^{HC}} - \frac{\partial b}{\partial P^{HC}}\right)}\right)} \tag{2.20}$$

To compare the number of workers in high-cost and low-cost commuting jurisdictions and the dependence on residential and production externalities, we rearrange the total derivative for the number of workers in high-commuting cost jurisdictions (see equation (2.20)). In high-commuting cost jurisdictions, a change in public goods affects the marginal worker. The effect is exaggerated by the decrease in residential externalities and dampened by increasing house prices. In low-commuting cost jurisdiction, an increase in public goods affects workers only indirectly via the marginal commuter. Thus, the effect on workers depends strongly on the relationship between population and amenity. The denominator captures production externalities for both jurisdiction' types. Whether they are stronger in low-commuting cost jurisdictions compared to high commuting cost jurisdictions depends on the marginal change in housing prices and second amenity for a marginal change in population. If the first exceeds the latter, they are stronger for low-commuting cost jurisdiction.

To sum up, we expect a change in public good provision to affect employment in the short run only in high-commuting cost jurisdictions. Under reasonable assumptions, population and thus house prices should, however, respond similar.

The long run impact is larger as well as likely to be less different between the two types of jurisdiction, if both, urbanization and production externalities, are relevant. We expect that in low and high-commuting cost jurisdictions, population as well as the number of workers increases. Further, the increase in population should be larger in high-commuting cost jurisdictions and equal to the change in employment. For high-commuting cost jurisdictions the employment effect depends on the strength of residential and production externalities. If they are sufficiently strong, employment is likely to change more than population as less out-commuting occurs.

IV. Empirical Strategy

In this section, we explain our empirical strategy to test the predictions outlined in the previous section. To assess the short run impact of the local availability of grammar schools we rely on a difference-in-differences (DiD) design that exploits school closures in all East German states between 1997 and 2008. To identify the long run impact, we apply an instrumental variable (IV) strategy for school openings after 1990 in East Germany using information about the historical availability of higher education institutions as excluded instruments.

A. Difference-in-Differences Strategy

The identification strategy for the short term effect is a comparison of jurisdictions with and without the closure of their only grammar school before and after the closing. Our baseline fixed effects estimation equation reads:[10]

$$Y_{i,t} = \alpha_i + \beta_1 TR_i * Close_{i,t} + \gamma X_{i,t} + \nu_t + \lambda_i + \epsilon_{i,t} \tag{2.21}$$

Our dependent variable is the natural logarithm of residential employees (employees that live and work in the same municipality) and stems from the Federal Employment Agency. Our treatment group (TR_i) includes all jurisdictions with one grammar school in 1997 that was closed until 2008. The data for grammar schools is hand-collected and cross-checked with the number of grammar schools available on a county level for Germany. We focus on jurisdictions with one grammar school as we believe that this provides the best variation for our analysis. In principle, school closures in cities with more than one grammar school could also be used if these closures cause excess demand for grammar schools. However, we do not have information on the number of students on the school level and thus are not able to account for school size (changes).

Since not all school closures happened in the same year, the reform variable ($Close_{i,t}$) is jurisdiction-specific and is one for all years for which the jurisdiction had one higher secondary education school less. The number of school closures for each year is shown in Table (2.2). Most of the school closures happened after 2002. The geographical location of schools and school closures in East Germany is depicted in Figure (2.1). The majority of school closures took place in Saxony and Saxony-Anhalt.

Our control group consists of jurisdictions with one grammar school in 1997 which was open at least until 2008. We include only jurisdictions with one grammar school to ensure that treatment and control group jurisdictions are similar in size without further sample restrictions. On average jurisdictions with one grammar school have between 500 and 30,000 inhabitants (see Figure 2.4 in Appendix A).

Our set of control variables, captured in the matrix $X_{i,t}$ includes the logarithm of population in 1997 interacted with year dummies, the local business tax (which is

[10]In a robustness analysis, we also estimate a Poisson model. Results are basically unchanged.

Table 2.2: School Closings and Openings in Municipalities with One School and with at Least Two Schools in 1997

	Schools = 1			Schools ≥ 2		
Year	Schools	Openings	Closings	Schools	Openings	Closings
1997	262	0	0	345	1	2
1998	263	1	0	341	0	3
1999	263	0	0	343	0	1
2000	264	2	1	339	2	3
2001	262	0	2	334	2	7
2002	261	1	2	326	1	9
2003	254	0	7	305	0	14
2004	251	1	4	288	1	16
2005	248	4	7	270	2	14
2006	243	0	5	263	1	7
2007	240	2	5	255	0	7
2008	238	3	5	253	0	2

Source: Own data collection and calculations.

set by the municipality) and the number of higher education schools within 10km distance. The variables stem from *Statistik Lokal* and are provided by the Federal Statistical Office. The variables ν_t and λ_i in equation (2.23) represent time and municipality fixed effects. We report heteroscedasticity-robust standard errors clustered at the municipality level.

$$Y_{i,t} = \alpha_i + \beta_1 TR_i * Close_{i,t} + \beta_2 TR_i * Close_{i,t} * C_i + \gamma X_{i,t} + \nu_t + \lambda_i + \epsilon_{i,t} \quad (2.22)$$

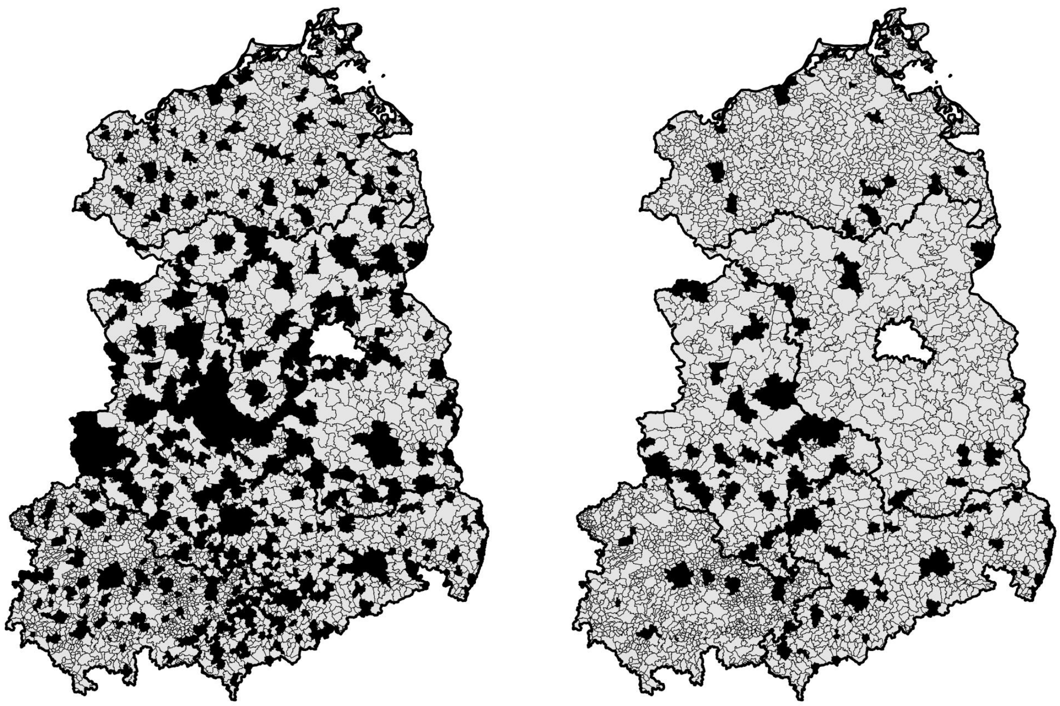
To account for a potential different impacts of school closures on local employment in jurisdictions with a large and a small share of out-commuters as predicted by the theoretical framework, we construct an indicator variables (C_i) that is one if the share of out-commuters in 1998 is above the mean and interact it with the treatment and reform interaction (see equation (2.22)).[11]

Descriptive statistics for the treatment and control group for 1997 are reported in Table (2.3). The average control group jurisdiction is larger than the treatment group jurisdiction, with respect to the population as well as the number of workers.

[11]We use 1998 data as out-commuters are not observed for all jurisdiction in 1997. In a robustness check, we also estimated the regression separately for the two sub-samples. Results are qualitatively unchanged and available upon request.

Figure 2.1: Schools and School Closings in East Germany between 1997 and 2008

(a) Schools > 0 (b) Closings



Comparing treatment and control group jurisdictions with a high and a small share of out-commuters gives a similar picture. Jurisdictions with a larger share of out-commuters are smaller and also have less employees.

Although our estimation strategy accounts for level differences by including municipality fixed effects, the level differences raise concerns about the common trend assumption of treatment and control group. To assess the plausibility of this assumption, we estimate a more flexible specification which includes 4 leads and 4 lags of school closure. Another concern regarding the level differences is that we are picking up treatment heterogeneity that is unrelated to the share of out-commuters. One particular strong concern in this regard is the difference in the number of schools within 10km radius between jurisdictions with a low and a high share of out-commuters. Given the potential correlation, our estimation strategy could simply pick up that additional commuting costs due to a school closure are lower in jurisdictions with a high share of out-commuters. To address this concern, we will

Table 2.3: Descriptive Statistics Local Employment Sample for 1997

	Control Group		Treatment Group	
Out-Commuter Share	Low	High	Low	High
Employees	2,422	1,269	1,679	1,034
	(1,369)	(841)	(708)	(366)
Population in 1000 (1997)	13.70	11.01	9.98	9.18
	(6.32)	(6.68)	(4.51)	(4.09)
Area in km^2	76.65	62.31	72.93	75.37
	(72.51)	(54.24)	(39.04)	(61.34)
# Schools (0 – 10km)	0.51	1.67	0.42	1.24
	(0.86)	(3.67)	(1.00)	(1.33)
Local Business Tax in Points	324.01	329.05	342.42	333.00
	(37.71)	(41.75)	(31.76)	(37.91)
Observations	103	96	12	26

Source: Authors' calculations based on data from Federal Employment Agency and Statistic Local, 1997 – 2008.

estimate also a specification in which we include interaction effects of the treatment variables with the number of schools within a 10km radius. Finally, we complement the analysis of the number of workers by investigating the impact of grammar school closures on house prices as well. If the additional commuting costs due to the school closure is the same in jurisdictions with a small and a large share of out-commuters and the loss in preferences for commuters as included in the model is sufficiently small, house prices should respond similar.[12]

The data for the house price analysis stems from Empirica AG and includes offer price data for a wide range of objects from newspapers as well as online ads covering the years 2004 to 2008. We merged municipality information to this data set using information on the location of the properties. The following types of properties are included in the analysis: single family homes, semi-detached houses, and terraced houses. We focus on purchase offers and not rental offers as housing markets in mid-sized town in East Germany are mainly purchase markets. Due to a very low number of treated observations (below 50) in the states of Thuringia and Brandenburg, we exclude these two states completely. Although the offer price data has the potential disadvantage of selection driving the results, we believe that this is addressed by our estimation strategy, which accounts for municipality and time fixed effects.

Since houses are usually sold with land, we use the natural logarithm of the overall

[12]We cannot assess the impact of the population using the DiD design as treatment and control group do not seem to follow a common trend before the reform.

price as the dependent variable and control for the amount of land as well as living space. While accounting for a wide range of property characteristics is likely to increase the efficiency of our estimates, it is also likely to cause a selection bias as adverts differ strongly regarding the non-essential information included in the ad (e.g. location in the city, close to public transport or not, etc). Thus, we include in our analysis only baseline property characteristics that are likely to be stated if existent. These are type of property, amount of land and living space, information on the condition of the property (high quality, newly built, renovated, in need of renovation) and availability of balcony, garage and basement. Further, we include the same municipality characteristics as in the analysis of local employment.

Descriptive statistics for the treatment and control group are shown in Table (2.4). On average a house in the sample costs about between 120,000 and 140,000 Euro and comes with 790 to 1080 square meters of land and 140 square meters living space. The houses in the treatment group are substantially less expensive (136 to 137 compared to 123 to 128 thousand Euro). As before, in particular remarkable is the strong difference in the number of grammar schools within a 10km radius, which is larger for low-commuting cost jurisdictions.

B. Instrumental Variable Strategy

To asses the long run impact of grammar schools we focus on grammar school openings in East Germany after the German re-unification in 1990. This allows us to account for adjustments over a period of 18 years, and we are less constrained by the availability of data and the small number of observations used for school closures. It comes, however, at the costs that we estimate the short run effect for school closures and the long run effect for school openings. If there is symmetry in the effects, this should not invalidate our analysis. However, Glaeser and Gyourko (2005) and Notowidigdo (2011) have shown that positive and negative local labor market shocks affect housing prices differently, as housing is a durable good and thus housing supply elasticities are larger (smaller) for increases (decreases) in housing

Table 2.4: Descriptive Statistics House Price Sample for 2004 to 2008.

	Control Group		TR Group	
Out-Commuter Share	Low	High	Low	High
Price	136,369.52	137,284.56	128,414.56	123,802.50
	71,436.48)	(74,260.91)	(70,407.97)	(64,507.61)
Amount of Land	879.04	792.07	1080.82	833.21
	(970.44)	(791.07)	(1093.70)	(908.13)
Living Space	138.02	136.92	136.18	134.31
	(57.86)	(54.18)	(55.11)	(51.90)
Single Family House	0.76	0.80	0.84	0.79
	(0.43)	(0.40)	(0.37)	(0.41)
Detached House	0.14	0.12	0.12	0.12
	(0.35)	(0.32)	(0.33)	(0.33)
Terraced House	0.10	0.08	0.04	0.09
	(0.30)	(0.28)	(0.20)	(0.29)
Balcony	0.08	0.08	0.08	0.09
	(0.28)	(0.27)	(0.27)	(0.29)
Garage	0.54	0.53	0.58	0.52
	(0.50)	(0.50)	(0.49)	(0.50)
Basement	0.19	0.21	0.20	0.22
	(0.40)	(0.41)	(0.40)	(0.41)
High Quality	0.10	0.12	0.10	0.09
	(0.30)	(0.32)	(0.30)	(0.29)
Renovated	0.21	0.21	0.19	0.18
	(0.41)	(0.41)	(0.39)	(0.39)
In Need of Renovation	0.22	0.20	0.22	0.19
	(0.41)	(0.40)	(0.42)	(0.39)
Newly Build	0.05	0.07	0.05	0.07
	(0.23)	(0.25)	(0.23)	(0.25)
Population in 1000 (1997)	15.03	15.19	8.80	11.06
	(5.72)	(7.30)	(2.45)	(4.11)
Area in km^2	67.67	68.88	66.55	72.42
	(44.01)	(56.01)	(33.56)	(37.18)
# Schools ($0-10$km)	0.47	2.55	0.16	1.11
	(0.90)	(4.98)	(0.55)	(1.23)
Local Business Tax in Points	348.30	362.14	360.14	352.24
	(42.82)	(41.81)	(34.73)	(34.36)
Property Tax in Points	360.83	372.07	371.91	370.05
	(38.79)	(43.42)	(34.92)	(39.17)
Observations	12798	13184	1178	3671

Source: Own data collection and calculations.

demand. Even so, since we estimate only the short run effect for school closure, we expect that housing supply adjustment do not affect our estimate.

As outlined in Section II, we believe that the German re-unification provides a suitable setting for analyzing the long run impact as it provides exogenous variation in the availability of grammar schools due to the regime change. Despite this unique setting, there are two challenges when estimating the impact of grammar schools on local employment in the cross-section.

First, grammar school openings are likely to correlate with political governance quality which is not observed. We address this concern by implementing an instrumental variable approach using historical information on the local availability of higher education institutions as excluded instruments. In particular, we use an indicator variable for whether the jurisdiction had a higher education school around 1914. Since higher education schools in Prussia had a school track allowing graduates to apply for university and thus are similar to grammar schools today, we expect them to be positively correlated with the openings of grammar schools after 1990. Out from the different school types in Prussia, we only use grammar schools as the number of other school types is rather limited.[13] Our second instrument exploits the role of cloister for higher education. The data stems from the cloister database (*Klosterdatenbank*) of the *Akademie der Wissenschaften zu Goettingen*. The database covers cloister that existed until 1800 with information on the foundation data and the religious orders. Here, we use the number of cloisters within a jurisdiction that existed between 1400 and 1500.[14] We use this specific time frame as in this century cloisters started offering education also to the general public.[15] For a graphical illustration of the higher education schools in Prussia and the jurisdictions with cloisters between 1400 and 1500 see Figure (2.2).

[13]The data stems from a publication in the "Die hoeheren Lehranstalten fuer die maennliche Jugend"' from 1914.

[14]More specifically, we use the number of cloisters squared as the likelihood of having a grammar school increases non-linear with the number of cloisters between 1400 and 1500.

[15]In a robustness check we required the existence only between 1400 and 1450 or 1450 and 1500. Results are basically unchanged. We also tried to use only particular cloisters which are more likely to offer education to the general public but the instruments were not strong enough.

The second challenge for our identification strategy is caused by the solution to the first since historical institutions for higher education are likely to have driven agglomeration economies in jurisdictions. We address this potential co-founding by including a wide range of agglomeration economies measures in 1990 as control variables.

To exploit binary variation whether a grammar school is available or not, we limit the sample to jurisdictions with not more than 1 grammar school in 2008 and at least 500 and not more than 30,000 inhabitants in 1990. Within this size range, the probability of having a grammar school is larger than 0 and smaller than 1. Further, to assess the long-run impact we only use data for the year 2008.[16] We implement the IV strategy by a two-stage least squares estimation. Our IV estimation equation reads:

$$D(School)_{j,t} = \alpha + \beta_1 D(\text{Prussia})_j + \beta_2 \text{Cloister}_j + \delta X_{i,t} + \phi_{i,t} \tag{2.23}$$

$$Y_{i,t} = \alpha + \beta D(Sc\hat{h}ool)_{j,t} + \gamma X_{i,t} + \omega_{i,t} \tag{2.24}$$

In a first step, we regress the dummy for the presence of a grammar school on our excluded instruments and the control variables. We then us the predicted value for the presence of a grammar school in a second step to estimate the causal relationship of the presence of a higher education school on the local economy, measured by the number of employees. Our set of control variables includes the deciles of the population in 1990, population density, the natural logarithm of jurisdiction size, area used for buildings, natural logarithm of distance to the next highway in 1937 and distance to the next railway in 1890.[17] Further, we control for the natural logarithm of the population in 1990 within a 50km radius, the ratio of jurisdictions' population to the largest city population within 50km distance, and the natural logarithm of the distance to the next city with more than 50.000 and more than

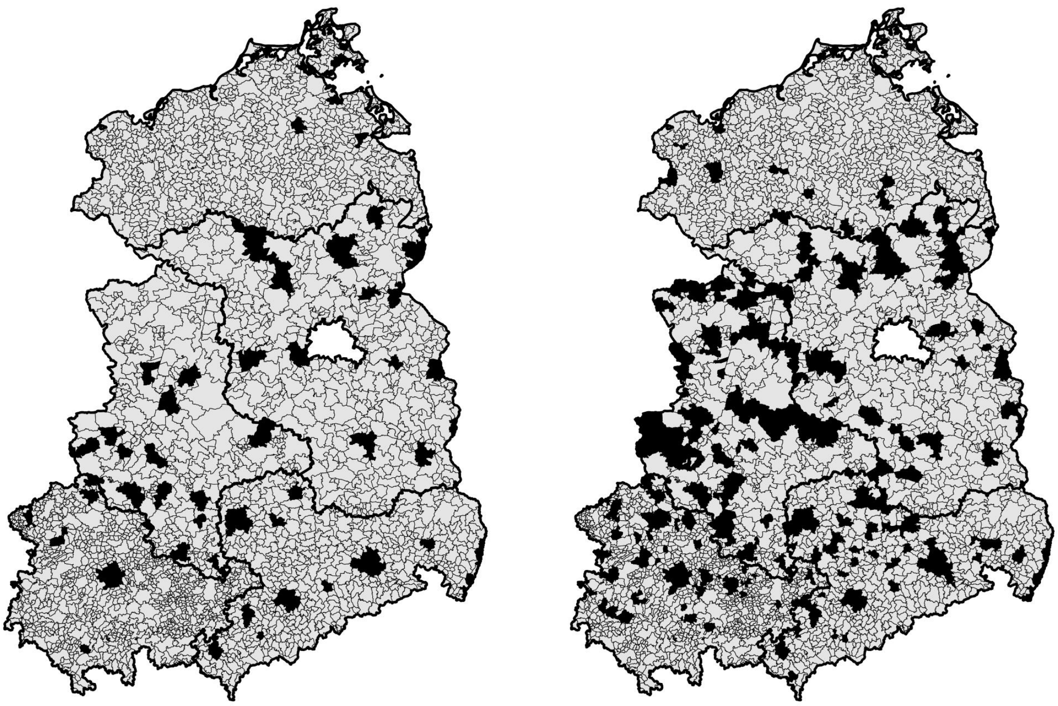
[16]Results are similar when using 2007.

[17]Note that we have no information on the specific location of a motorway access or railway station. Hence, the distance to the next highway or railway serves as a proxy.

100.000 inhabitants. Moreover, we account for the number of grammar schools within 10km distance. Finally, we account for the number of cloisters that existed within the jurisdiction as well as the distance to the next Prussian school or cloister that existed between 1400 and 1500. The idea behind this is to account for spatial correlation of cloisters founded between 1400 and 1500 and Prussian schools. On top, in a robustness check we also include state as well as county fixed effects and an indicator variable for the presence of a higher education school before 1990.

Figure 2.2: Higher Education Schools in Prussia and Cloister

(a) Higher Education Schools in Prussia (b) Cloister between 1400 and 1500



Descriptive statistics for the sample are reported in Table (2.5). Compared to the DiD sample' jurisdictions, the communities in this sample are much smaller with 3,530 inhabitants (in 1990) and 276 employees in 2008. The reason is that we include jurisdictions with no grammar school in this sample, which are on average much smaller than jurisdictions with grammar schools.

Table 2.5: Descriptive Statistics (Instrumental Variable Strategy) Local Employment Sample in 2008

	Mean	Median	Std. Dev.
Employees	274.66	83.00	500.86
Population in 1000	3.25	1.68	4.02
Population in 1000 (1990)	3.53	1.76	4.54
Area in km^2	38.37	26.96	39.22
Area Buildings in km^2 (1996)	142.07	88.00	151.07
Population/Area	0.12	0.07	0.15
Population within 50km Distance	364.89	147.28	762.10
Population to Largest Population within 50km Distance	0.03	0.01	0.05
Distance to Highway (1937)	14.70	11.67	12.67
Distance to Railway (1890)	5.50	4.07	5.69
Distance to City with more than 100.000 Inhabitants	42.97	37.20	26.06
Distance to City with more than 50.000 Inhabitants	24.62	22.75	12.40
# Cloister	0.10	0.00	0.44
# Schools (0 – 10km)	1.24	1.00	1.60
Distance to Cloister that existed betw. 1400 and 1500	17.77	11.85	18.88
Distance to Higher Education School in Prussia	27.78	21.33	22.56
Observations	2037		

Source: Own data collection and calculations.

Similar to the DiD analysis, we complement the analysis of the number of workers by estimating the impact of grammar school openings on the population as well as on house prices. Descriptive statistics for the latter are reported in Table (2.6). The average house is very similar to the DiD analysis, it is slightly more expensive but comes with more land as it is more likely to be a single family home. The size of the jurisdiction, measured by population and area, is somewhat smaller. Again, this reflects the fact that we have included jurisdictions with no grammar schools as well.

V. Results

In the following we present the results of our DiD and IV strategy starting with the first.

A. Difference-in-Differences Results

Table (2.7) shows the DiD results. In all specifications we use the natural logarithm of residential employment as the dependent variable. In the first column we do not distinguish between the share of out-commuters in jurisdictions and do not

Table 2.6: Descriptive Statistics (Instrumental Variable Strategy) House Price Sample in 2008

	Mean	Median	Std. Dev.
Price	144,215.40	139,386.00	72,380.05
Amount of Land	950.38	665.00	956.19
Living Space	134.00	123.00	49.69
Single Family House	0.84	1.00	0.37
Detached House	0.10	0.00	0.31
Terraced House	0.06	0.00	0.23
Balcony	0.10	0.00	0.30
Garage	0.53	1.00	0.50
Basement	0.23	0.00	0.42
High Quality	0.13	0.00	0.33
Renovated	0.18	0.00	0.39
In Need of Renovation	0.20	0.00	0.40
Newly Build	0.08	0.00	0.27
Construction Year	1976	1996	43
Mean Construction Year in Municipality	1971	1975	20
Population in 1000 (1990)	7.85	5.74	6.67
Area in km^2	65.71	46.17	65.11
Area Buildings in km^2 (1996)	330.55	264.00	245.45
Population/Area	0.19	0.10	0.23
Population within 50km Distance	1,176,300.46	315,277.00	1,616,551.40
Population to Largest Population within 50km Distance	0.04	0.01	0.08
Distance to Highway (1937)	11.92	7.58	12.47
Distance to Railway (1890)	5.52	3.98	5.70
Distance to City with more than 100.000 Inhabitants	34.12	26.58	23.68
Distance to City with more than 50.000 Inhabitants	22.15	19.67	11.16
# Cloister	0.18	0.00	0.57
# Schools $(0-10\text{km})$	1.49	1.00	2.06
Distance to Cloister that existed betw. 1400 and 1500	18.16	13.38	18.59
Distance to Higher Education School in Prussia	25.50	19.67	21.55
Observations	62,200		

Source: Own data collection and calculations.

find evidence that school closures affect local employment. From column (2) onward we account for a potential different impact of commuting on employment and our results confirm the presumption. The results suggest that closing a grammar school reduces employment by about 9% in a jurisdiction with a small share of out-commuters but has no impact on employment in a jurisdiction with a large share of out-commuters. The point estimate changes little when including additional control variable as the local business tax rate or the number of grammar school within 10km radius (column (3)) or state-year fixed effect (column (4)). Results are also similar when using the share of out-commuters as continuous variables or the overall employment in the jurisdiction as dependent variable (not reported). In column (5) we address the concern that commuting in jurisdictions with high and low share of out-commuters is simply different. However, the point estimate for the main effect changes little (although the interaction effect is less precisely estimated). Interestingly to note is that the number of grammar schools within 10km radius does affect the employment effect for jurisdictions with a high share of out-commuters. Thus, if there is a sufficient number of grammar schools close by the employment effects are less strong. This relationship is, however, absent for jurisdictions with a low share of out-commuters, which suggests that commuters do not want to commute in two ways and thus prefer to move away. In column (6) we use an indicator variable for jurisdictions with low commuting costs (instead of the observed share of out-commuters). The indicator variable is one if the jurisdictions is closer than the median jurisdiction to a highway or railway. Results are basically unchanged.

Table 2.7: Baseline Estimation Results for Residential Employment

	Dependent Variable: (ln) Employees (Residents)					
	(1)	(2)	(3)	(4)	(5)	(6)
TR X Close	-0.025	-0.090**	-0.087**	-0.078*	-0.096**	-0.081**
	(0.027)	(0.042)	(0.038)	(0.040)	(0.042)	(0.039)
TR X Close X High Commuter (HC)		0.092*	0.094**	0.086*	0.085	
		(0.053)	(0.048)	(0.048)	(0.057)	
TR X Close X Low Commuting Costs (LCC)						0.095**
						(0.047)
TR X Close X # Schools (0 − 10km)					0.079***	
					(0.021)	
TR X Close X # Schools (0 − 10km) X HC					-0.065*	
					(0.034)	
Close (t+1)		-0.003				
		(0.026)				
Close (t+1) X HC		-0.022				
		(0.041)				
Close (t+2)		-0.004				
		(0.024)				
Close (t+2) X HC		0.001				
		(0.035)				
# Schools (0 − 10km)			-0.012	-0.015	0.019	-0.015
			(0.010)	(0.010)	(0.015)	(0.010)
# Schools (0 − 10km) X HC					-0.038**	
					(0.019)	
(ln) Local Business Tax in Points			0.099	0.029	0.033	0.038
			(0.140)	(0.136)	(0.138)	(0.137)
N	2591	2591	2591	2591	2591	2591
F	37.00***	34.32***	34.84***	32.97***	35.04***	33.63***
R sq	0.54	0.54	0.54	0.56	0.56	0.56
Year Fixed Effects	✓	✓	✓	✓	✓	✓
Municipality Fixed Effects	✓	✓	✓	✓	✓	✓
(ln) Population (1997) X Year	✓	✓	✓	✓	✓	✓
(ln) Area X Year	✓	✓	✓	✓	✓	✓
State X Year Fixed Effects				✓	✓	✓

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the municipality level in parentheses. *Source:* Own data collection and calculations.

Since the validity of the DiD approach is based on the common trend assumption, we investigate this in more detail. First, we inspect the coefficients for the two leads school closures included in column (2). These are basically zero and thus supports the common trend assumption. Further, we estimate a more flexible specification, which includes up to four leads and four lags. The point estimates are illustrated in Figure (2.3). Again, the pre-trend for both types of jurisdictions is very flat before school closure. Besides shedding light on the common trend before the school closure the more flexible approach also reveals that the employment effect is increasing over time, and around 16% after 4 years.

Table 2.8: Baseline Estimation Results for House Prices

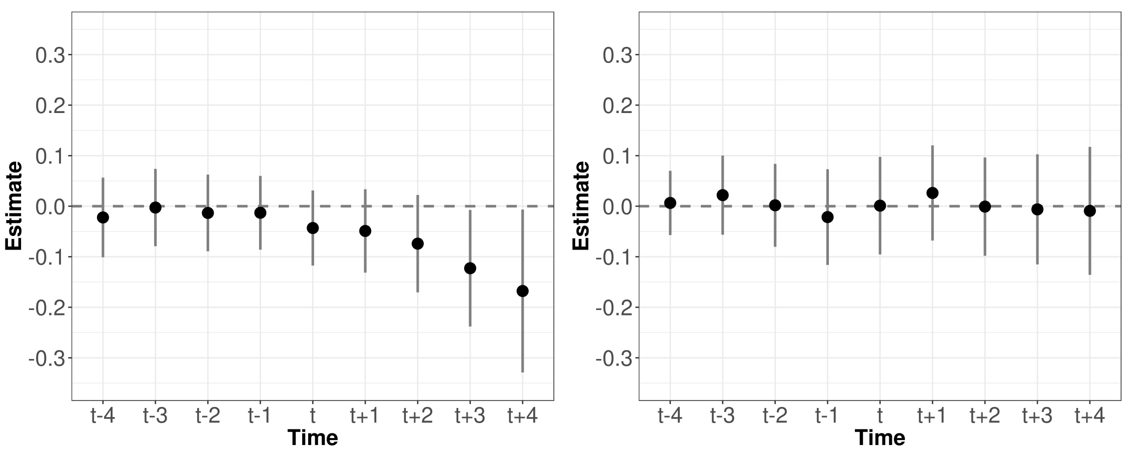
	Dependent Variable: (ln) House Price					
	(1)	(2)	(3)	(4)	(5)	(6)
Close (t+2)	0.022	0.022	0.027	0.026	0.027	0.032
	(0.025)	(0.024)	(0.025)	(0.034)	(0.033)	(0.027)
Close (t+2) X High Commuter (HC)			-0.008	-0.014	-0.014	
			(0.039)	(0.043)	(0.043)	
Close (t+2) X Low Commuting Costs (LCC)						-0.029
						(0.043)
Close (t+1)	-0.063					
	(0.048)					
TR X Close	-0.065					
	(0.043)					
Close (t+1) or TR X Close		-0.064	-0.068*	-0.109***	-0.109***	-0.112***
		(0.043)	(0.037)	(0.038)	(0.038)	(0.032)
Close (t+1) or TR X Close X High Commuter (HC)			0.005	0.028	0.028	
			(0.065)	(0.059)	(0.059)	
Close (t+1) or TR X Close X Low Commuting Costs (LCC)						0.030
						(0.059)
(ln) Property Tax in Points	0.118	0.120	0.119	-0.021	-0.024	-0.021
	(0.299)	(0.298)	(0.298)	(0.279)	(0.279)	(0.279)
(ln) Local Business Tax in Points	0.001	0.002	0.002	0.059	0.059	0.059
	(0.261)	(0.260)	(0.260)	(0.245)	(0.245)	(0.245)
# Schools ($0-10$km)	-0.001	-0.001	-0.001	-0.003	-0.019	-0.003
	(0.009)	(0.010)	(0.010)	(0.008)	(0.023)	(0.008)
# Schools ($0-10$km) X High Commuter (HC)					0.017	
					(0.025)	
N	30831	30831	30831	30831	30831	30831
F	74.87***	77.36***	.	.	.	68.90***
R sq	0.23	0.23	0.23	0.23	0.23	0.23
Property Controls	✓	✓	✓	✓	✓	✓
(ln) Population (1997) X Year	✓	✓	✓	✓	✓	✓
(ln) Area X Year	✓	✓	✓	✓	✓	✓
Year Fixed Effects	✓	✓	✓	✓	✓	✓
Municipality Fixed Effects	✓	✓	✓	✓	✓	✓
State-Year Fixed Effects				✓	✓	✓

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the municipality level in parentheses. *Source:* Own data collection and calculations.

Although our results have shown that they do not hinge on a correlation between the share of out-commuters and the additional commuting if grammar schools are closed, the results could still be driven by different preferences. To assess the relevance of these arguments, we investigate whether house prices drop similar in both types of jurisdictions. The results are reported in Table (2.8). In the first column, we do not distinguish between jurisdictions with a small or large share of out-commuters and include two leads. The results suggest that there is a price drop (although not significant) already in t+1 which reflects the role of expectations in house prices. This is consistent with anecdotal evidence that school closures are announced up to 2 years earlier. We thus change the treatment effect such that it is one from t+1 onward. Further, we include (starting in column (3)) an interaction effect with an indicator variable that is one if the share of out-commuters is above the median. While the interaction effect is relatively small and not significant, the treatment effect turns significant and suggests that house price dropped by 6.8% in response to a school closure. Including state-year fixed effects in column (4) increases the treatment and the interaction effect but the latter remains insignificant. In column (5) we assess to which extent the positive coefficient for the interaction effect is driven by differences in the additional commuting time in jurisdictions with a low and a high share of out-commuters by including interaction effects between the treatment variables and the number of grammar schools within 10km radius. Our results do not change. In column (6) we use the alternative measure for jurisdictions with a high share of out-commuters that is based on the distance to the next highway or railway. The results are basically unchanged. We conclude that unobserved factors do not seem to drive the results as house prices drop to a similar extent. Further, the results confirms that people value the availability of grammar schools within a jurisdiction. The average willingness to pay amounts in absolute terms to about 13,000 Euro or roughly 11% of the property value. This seems plausible as pupils attend grammar schools for on average 200 days for 8 years. Hence, using a discount rate of 3% and 1 hour additional commuting time, we derive an hourly rate between 8 and 9 Euros.

Figure 2.3: Estimation with Four Leads and Lags

(a) Low Share of Out-Commuter (b) High Share of Out-Commuter



Notes: The figure depicts the point estimates and 5% confidence intervals using a regression with four leads and lags of schools closure and controlling for year times (ln) population 1997, year times (ln) area as well as year and municipality fixed effects.

B. Instrumental Variable Results

The subsequent analysis will turn to the long run impact of the local availability of schools. We start with the impact on the overall population in a jurisdiction.

If urbanization and residential externalities are present, population should increase stronger in high-commuting cost jurisdictions, otherwise population should increase to the same extend. The results are reported in Table (2.9). Column (1) presents the OLS estimate and column (2) the IV estimate using cloisters that existed between 1400 and 1500 and Prussian schools as excluded instruments. The Hansen test for over-identifying restrictions cannot be rejected, which means the exogeneity of one instrument given the exogeneity of the other cannot be rejected. Further, the instrument have some power as the Kleibergen and Paap (2006) rank F-Statistic for weak instruments is above 10. The estimated coefficients for our excluded instruments on the first stage are shown at the bottom of the table and are consistent with our expectations.[18] Using the IV strategy, the point estimate for the school variable increases to 70%. This suggests that agglomeration forces are important for the long run effect. Results are somewhat smaller, if we only use the stronger of the two excluded instruments, namely the Prussian school dummy, and somewhat larger if we additionally account for the presence of grammar schools in the GDR as well as county fixed effects (see columns (3) and (4) in Table (2.12) in Appendix B).

Table 2.9: Long-run effects of Higher Education Schools on Local Population

	Dependent Variable: (ln) Population					
Method	OLS	IV using Cloisters (1400-1500) and Prussian Schools				
Criteria			Highway and Railway		Highway	
Commuting Costs			Low	High	Low	High
	(1)	(2)	(3)	(4)	(5)	(6)
School	0.14***	0.70***	0.60***	1.10***	0.41*	0.93***
	(0.02)	(0.18)	(0.20)	(0.31)	(0.23)	(0.26)
N	2037	2037	1443	594	975	1062
Weak Instrument Test†		11.17	13.35	3.07	10.33	4.78
Hansen J p-Value		0.27	0.40	0.45	0.25	0.86
Population Percentiles	✓	✓	✓	✓	✓	✓
Location Characteristics	✓	✓	✓	✓	✓	✓
First Stage Estimates						
Prussian Schools		0.31***	0.40***	0.02	0.44***	0.16*
		(0.08)	(0.08)	(0.12)	(0.10)	(0.09)
# Cloister (1400 and 1500), sqrd.		0.05**	0.04	0.06**	-0.00	0.07**
		(0.02)	(0.04)	(0.03)	(0.05)	(0.03)

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. *Source:* Own data collection and calculations. *Notes:* Cluster robust standard errors are in parentheses. †Kleibergen and Paap (2006) rank F-statistic for stationary data.

Next we account for differences between jurisdictions with high and low commuting costs by splitting the sample according to the costs of commuting. In column (3)

[18]We only depict the point estimates for schools on the dependent variables. For the complete regression tables see Appendix C.

we only include jurisdictions that are closer than the median jurisdiction to either highway or railway. In column (4), all other jurisdictions are included. Column (5) and (6) use only the distance to highways to split the sample. Independent of the splitting criteria, the result suggests that population increased stronger, roughly twice as much, in high-commuting cost jurisdictions compared to low commuting cost jurisdictions. This suggests that production externalities are relevant as they are responsible for the different change in population.

The results for the long run impact of grammar schools on house prices are reported in Table (2.10). Column (1) reports the OLS estimate and columns (2) to (6) the IV estimates. The instrument strength drops in this sample but the test of overidentifying restrictions can again not be rejected. When using the IV approach, the point estimate increase to 0.29 and suggests that house prices are roughly 29% higher in jurisdiction with a grammar school. When using only the stronger one of the two instrument, the coefficient decreases slightly similar to the results for population. However, when including county fixed effects (as well as an indicator variables for higher education schools before 1990), the point estimate is not longer significant (see columns (5) and (6) in Table (2.12)). We believe that this is due to small sample power.Comparing the change in house prices in our baseline specification with the change in population suggests a house price elasticity with respect to population of 0.41. In column (3) to (6) we split again the sample according to the cost of commuting. Similar to the population results there is clear evidence that house prices increased stronger in high commuting cost jurisdictions. Interestingly, however, is that the house price elasticity seems to be smaller in low commuting costs jurisdictions. For high commuting cost jurisdictions it is between 0.34 and 0.61 (population change of 1.10 and 0.93 compared to house price change of 0.67 and 0.32) compared to between 0.33 and 0.41 for low commuting cost jurisdictions (population change of 0.41 and 0.6 compared to house price change of 0.17 and 0.20). One potential explanation for these findings could be that the risk of empty properties is lower in low-commuting cost jurisdictions as there will be demand for properties even if local conditions are not very strong due to low commuting costs to surrounding cities.

Table 2.10: Long-run effects of Higher Education Schools on House Prices

	Dependent Variable: (ln) House Price					
Method	OLS	IV using Cloisters (1400-1500) and Prussian Schools				
Criteria			Highway and Railway		Highway	
Commuting Costs			Low	High	Low	High
	(1)	(2)	(3)	(4)	(5)	(6)
School	0.04***	0.29***	0.20**	0.67***	0.17*	0.32**
	(0.01)	(0.09)	(0.09)	(0.23)	(0.09)	(0.14)
N	62072	62072	48010	14062	37960	24112
Weak Instrument Test†		16.85	13.30	4.67	8.38	11.89
Hansen J p-Value		0.19	0.45	0.62	0.57	0.92
Population Percentiles	✓	✓	✓	✓	✓	✓
Location Characteristics	✓	✓	✓	✓	✓	✓
Property Characteristics	✓	✓	✓	✓	✓	✓
First Stage Estimates Prussian School		0.46***	0.46***	0.30*	0.52***	0.41***
		(0.09)	(0.10)	(0.16)	(0.14)	(0.11)
# Cloister (1400-1500)		0.14*	0.17	0.14**	0.05	0.21***
		(0.08)	(0.13)	(0.06)	(0.17)	(0.06)

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. *Source:* Own data collection and calculations. *Notes:* Cluster robust standard errors are in parentheses. †Kleibergen and Paap (2006) rank F-statistic for stationary data.

Given that both, urbanization and residential externalities matters, we expect a positive employment effect in low and high-commuting cost jurisdictions. The results for employment are shown in Table (2.11). Column (1) presents the OLS result with a positive and significant point estimate. From column (2) onward we use the instrumental variable approach. The instrument strength is comparable to the population results. The test of over-identifying restrictions cannot be rejected. Quantitatively, the point estimate suggests a long run increase in residential employment of around 146%. Results are not sensitive to using only Prussian schools as excluded instrument or accounting in addition for county fixed effect as well as an indicator variable for the presence of higher education schools before 1990 (see columns (1) and (2) in Table (2.12)). In column (3) to (6) we estimate the effects for different subsamples according to the costs of commuting for jurisdictions. While the employment effect seems smaller in high commuting cost jurisdictions when using highways and railways as splitting criteria, this is reversed when using only highways. Thus, we conclude that there is no different employment effect in the two jurisdiction' types.

While we do find evidence that population does not exactly increase by the same factor as residential employment, we think the difference is relatively small (population changes by 93% or 110% while employment changes by 97% or 146% in high communing cost jurisdictions) and likely to be explained by differences in the non-working population or by less out-commuting as our splitting criteria does not

Table 2.11: Long-run effects of Higher Education Schools on Residental Employment

	Dependent Variable: (ln) Residental Employment					
Method	OLS	IV using Cloisters (1400-1500) and Prussian Schools				
Criteria			Highway and Railway		Highway	
Commuting Costs			Low	High	Low	High
	(1)	(2)	(3)	(4)	(5)	(6)
School	0.35***	1.46***	1.39***	0.97*	0.96**	1.46***
	(0.04)	(0.39)	(0.43)	(0.52)	(0.48)	(0.55)
N	2037	2037	1443	594	975	1062
Weak Instrument Test†		11.17	13.35	3.07	10.33	4.78
Hansen J p-Value		0.94	0.67	0.11	0.37	0.20
Population Percentiles	✓	✓	✓	✓	✓	✓
Location Characteristics	✓	✓	✓	✓	✓	✓
First Stage Estimates						
Prussian Schools		0.31***	0.40***	0.02	0.44***	0.16*
		(0.08)	(0.08)	(0.12)	(0.10)	(0.09)
# Cloister (1400 and 1500), sqrd.		0.05**	0.04	0.06**	-0.00	0.07**
		(0.02)	(0.04)	(0.03)	(0.05)	(0.03)

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. *Source:* Own data collection and calculations. *Notes:* Cluster robust standard errors are in parentheses. †Kleibergen and Paap (2006) rank F-statistic for stationary data.

only identify jurisdiction with no commuting but relatively low commuting flows.

Lastly, we use our estimates as well as our theoretical framework to quantify the importance of residential and production externalities. First, we derive the change in the value of public goods using the short run estimates. Based on the assumption that population changes as employment, we calculate a short run housing price elasticity of 0.69 (house prices change by 11% and employment in high commuting cost jurisdictions by 16% (after four years as shown in Figure (2.3)). Using the negative employment effect of 16% and equation (2.9), we derive at a reduction in the value of public goods due to the school closure of 0.27. Under the assumption that the loss in preferences is negligible, we can use the population estimates for the jurisdictions with low-commuting costs to quantify the role of residential externalities. Based on the estimate using distance to highways and railways as sample splitting criteria, we calculate that the first order derivative of the second amenity with respect to population is 0.88. This is based on equation (2.18) using the change in the valuation of the public good of 0.27, an estimated housing price elasticity of 0.33 (population changes by 0.6 and house prices by 0.20) and an estimated population change of 0.6. Further, we calculate the marginal change in wages with respect to the number of workers to be 0.62. This is based on equation (2.19), an estimated population change of 0.6, the marginal change in the value of the second amenity with respect to population of 0.88 and an estimated employment change of 139%. Using only highways as splitting criteria gives similar values, the marginal change in the second amenity with respect to population is 0.76 and the change in wages with respect to the number of workers is 0.68.

To cross-check these calculations, we can use the long run estimate for jurisdictions with high-commuting costs. While this does not allow to quantify residential and production externalities separately, it does allow to quantify the two forces in total. Using the estimates for the sample split based on highways and railway, we calculate - using equation (2.20), an estimated housing price elasticity of 0.69 and an estimated employment effect of 97% - a sum of marginal change in second amenity and change in wages with respect to population/number of workers of 1.41. Using the estimates for the sample split based solely on distance to highways gives a sum of 1.5. Taking standard errors this is similar to the calculated value using low-commuting cost jurisdictions. We conclude that the marginal change in the value of the second amenity with respect to population is between 0.76 and 0.88 and the marginal change in wages with respect to the number of workers is 0.62 to 0.68. The latter estimate is further comparable to the empirical results reported by Melo *et al.* (2009), who find that wages increase by roughly 0.8 for a marginal change in the number of workers.

VI. Conclusion

This article evaluates the importance of local schools for a jurisdictions' economy. Motivated by a stylized theoretical model which accounts for commuting as well as agglomeration economies, we investigate the short run and long run impact of school closures on local employment. As a testing ground, we focus on East Germany, which showed a unique development in the schooling landscape due to and after the reunification. We derive the short run impact by using a difference-in-differences design and find that employment decreases by roughly 16% after four years in jurisdictions with a small share of out-commuters. The reason for the different short run impact is that commuters are marginal inhabitants and thus may absorb negative or positive public good shocks by moving away and thus lowering house prices. Further, we show that house prices decreased by 11% in all jurisdictions with school closures. This rules out that different preferences drive the results. To assess the long run effects of the local availability of grammar schools we analyze school openings after the German re-unification in East Germany. We employ an instrumental variable approach which accounts for omitted variable bias and controls for agglomeration economies in 1990. Our excluded instrument is the number of cloisters that existed in the jurisdiction between 1400 and 1500 and the presence of a higher education schools in Prussia around 1914. We find a long run effect in the order of 146% and this effect differs not substantially between jurisdictions with low and high commuting costs. Commuting costs predict, however, whether the additional employment is mainly due to an inflow of workers (as for high commuting cost jurisdictions) or less out-commuting (as for low commuting cost jurisdictions). Finally, using our model and the empirical estimate we calculate that an additional worker in a jurisdiction increases residential and production externalities to the same extend.

The most important implication of our work for policy-makers is that public good provision can be used to stimulate agglomeration economies which are substantial forces in shaping the spatial distribution of people and employment. This is certainly good news, but also means that if public provision is more and more centralized in rural areas, this will fortify the trend in urbanization. An important avenue for future research suggested by our work is to understand why housing price elasticities are lower in low commuting costs jurisdiction in order to improve our understanding of housing supply adjustments. This is particular important, as a substantial part of the value of public goods is capitalized into housing prices.

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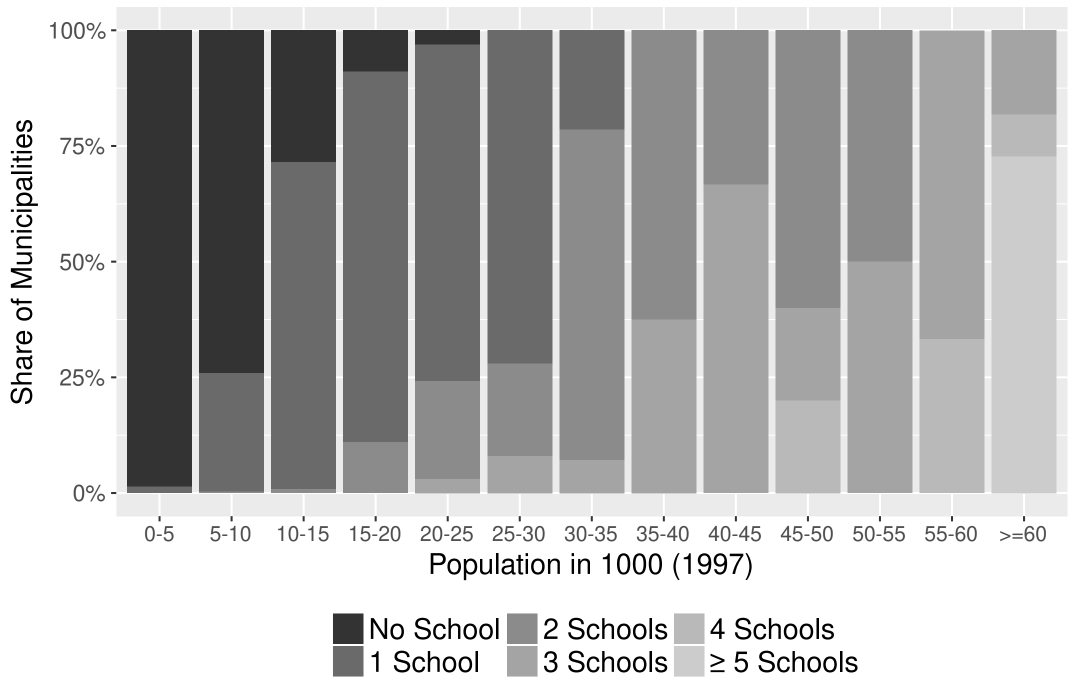
Figure (2.4) depicts the number of higher education schools in population bins from 0 to 60 thousand. Note that the number of higher education schools increases strictly with population.

Figure 2.4: Share of Municipalities with Grammar Schools



Appendix B: Sensitivity Analysis

Table 2.12: Sensitivity Analysis Long-run effects of Higher Education Schools

	(ln) Employees		(ln) Population		(ln) House Price	
	(1)	(2)	(3)	(4)	(5)	(6)
School	1.45***	1.53*	0.58***	0.90**	0.22**	0.15
	(0.46)	(0.79)	(0.20)	(0.36)	(0.09)	(0.14)
Higher Education School before 1990		-0.19		-0.16		-0.04
		(0.25)		(0.12)		(0.03)
N	2037	2037	2037	2037	62072	62072
Weak Instrument Test†	20.57	3.18	20.57	3.18	31.39	3.08
Hansen J p-Value		0.68		0.31		0.87
Population Percentiles	✓	✓	✓	✓	✓	✓
Location Characteristics	✓	✓	✓	✓	✓	✓
Property Characteristics					✓	✓
County Fixed Effects		✓		✓		✓
First Stage Estimates						
Prussian Schools	0.23***	0.16**	0.32***	0.16**	0.48***	0.05
	(0.07)	(0.08)	(0.07)	(0.08)	(0.08)	(0.11)
# Cloister (1400 and 1500), sqrd.		0.03		0.03		
		(0.02)		(0.02)		
# Cloister (1400 and 1500)						0.18**
						(0.08)

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. *Source:* Own data collection and calculations. *Notes:* Cluster robust standard errors are in parentheses. †Kleibergen and Paap (2006) rank F-statistic for stationary data.

Appendix C: Complete Regression Tables

Table 2.13: Complete Long-run effects of Higher Education Schools on Local Population

	Dependent Variable: (ln) Population					
Method	OLS	IV using Cloisters (1400-1500) and Prussian Schools				
Criteria			Highway and Railway		Highway	
Commuting Costs			Low	High	Low	High
	(1)	(2)	(3)	(4)	(5)	(6)
School	0.14***	0.70***	0.60***	1.10***	0.41*	0.93***
	(0.02)	(0.18)	(0.20)	(0.31)	(0.23)	(0.26)
(ln) Area in km^2	-0.02	-0.01	-0.01	0.04	-0.02	0.05**
	(0.01)	(0.02)	(0.02)	(0.03)	(0.02)	(0.02)
(ln) Area Buildings in km^2 (1996)	0.23***	0.22***	0.23***	0.15***	0.26***	0.13***
	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)	(0.02)
Population/Area	0.07	-0.04	-0.02	0.11	-0.05	0.23*
	(0.06)	(0.08)	(0.08)	(0.24)	(0.09)	(0.12)
(ln) Population within 50km Distance	0.19***	0.17***	0.17***	0.20***	0.24***	0.10***
	(0.04)	(0.04)	(0.04)	(0.06)	(0.04)	(0.04)
(ln) Population to Largest Population within 50km Distance	0.20***	0.17***	0.16***	0.22***	0.22***	0.12***
	(0.04)	(0.04)	(0.04)	(0.06)	(0.05)	(0.04)
(ln) Distance to Highway (1937)	-0.01***	-0.01**	-0.01*	-0.03	-0.01	-0.03
	(0.00)	(0.01)	(0.01)	(0.03)	(0.01)	(0.02)
(ln) Distance to Railway (1890)	0.00	-0.00	-0.01	0.06**	-0.00	0.00
	(0.00)	(0.00)	(0.01)	(0.02)	(0.01)	(0.01)
(ln) Distance to City with more than 100.000 Inhabitants	-0.10***	-0.09***	-0.11***	-0.04	-0.12***	-0.03
	(0.01)	(0.01)	(0.02)	(0.03)	(0.02)	(0.02)
(ln) Distance to City with more than 50.000 Inhabitants	-0.05***	-0.04***	-0.04**	-0.05**	-0.02	-0.07***
	(0.01)	(0.01)	(0.02)	(0.03)	(0.02)	(0.02)
# Cloister	-0.02	-0.00	-0.01	-0.16**	-0.03	-0.05
	(0.02)	(0.04)	(0.04)	(0.07)	(0.04)	(0.05)
# Cloister, sqrd	0.01	0.00	-0.00	0.07**	0.00	0.02
	(0.01)	(0.01)	(0.01)	(0.03)	(0.01)	(0.02)
# Schools ($0-10$km)	0.03***	0.04***	0.03***	0.08***	0.02***	0.06***
	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
(ln) Distance to Cloister that existed betw. 1400 and 1500	-0.02**	-0.01	-0.02*	-0.03**	-0.03**	-0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
(ln) Distance to Higher Education School in Prussia	0.01	-0.01	-0.00	-0.01	0.00	-0.01
	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)
N	2037	2037	1443	594	975	1062
Weak Instrument Test†		11.17	13.35	3.07	10.33	4.78
Hansen J p-Value		0.27	0.40	0.45	0.25	0.86
Population Percentiles	✓	✓	✓	✓	✓	✓

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. *Source:* Own data collection and calculations. *Notes:* Cluster robust standard errors are in parentheses. †Kleibergen and Paap (2006) rank F-statistic for stationary data.

Table 2.14: Complete Long-run effects of Higher Education Schools on Residental Employment

	Dependent Variable: (ln) Residental Employment					
Method	OLS	IV using Cloisters (1400-1500) and Prussian Schools				
Criteria			Highway and Railway		Highway	
Commuting Costs			Low	High	Low	High
	(1)	(2)	(3)	(4)	(5)	(6)
School	0.35***	1.46***	1.39***	0.97*	0.96**	1.46***
	(0.04)	(0.39)	(0.43)	(0.52)	(0.48)	(0.55)
(ln) Area in km^2	-0.13***	-0.11***	-0.06	-0.14**	-0.06	-0.09*
	(0.03)	(0.04)	(0.05)	(0.06)	(0.05)	(0.06)
(ln) Area Buildings in km^2 (1996)	0.31***	0.29***	0.28***	0.25***	0.35***	0.23***
	(0.04)	(0.04)	(0.05)	(0.06)	(0.06)	(0.05)
Population/Area	-0.33**	-0.55***	-0.49**	-0.21	-0.44**	-0.20
	(0.13)	(0.20)	(0.22)	(0.29)	(0.22)	(0.24)
(ln) Population within 50km Distance	0.18***	0.13**	0.10*	0.36***	0.14	0.13**
	(0.06)	(0.06)	(0.06)	(0.09)	(0.09)	(0.07)
(ln) Population to Largest Population within 50km Distance	0.29***	0.21***	0.19***	0.41***	0.26***	0.16**
	(0.06)	(0.06)	(0.06)	(0.10)	(0.10)	(0.08)
(ln) Distance to Highway (1937)	0.00	0.01	-0.00	0.09	-0.01	0.08*
	(0.01)	(0.01)	(0.01)	(0.06)	(0.02)	(0.04)
(ln) Distance to Railway (1890)	0.04***	0.03***	0.01	0.17***	0.03*	0.04***
	(0.01)	(0.01)	(0.01)	(0.05)	(0.01)	(0.01)
(ln) Distance to City with more than 100.000 Inhabitants	-0.12***	-0.11***	-0.13***	-0.09	-0.15***	-0.06
	(0.03)	(0.03)	(0.03)	(0.06)	(0.04)	(0.05)
(ln) Distance to City with more than 50.000 Inhabitants	0.12***	0.13***	0.10***	0.21***	0.13***	0.14***
	(0.03)	(0.03)	(0.03)	(0.05)	(0.04)	(0.04)
# Cloister	0.05	0.08	0.04	-0.05	-0.04	0.16
	(0.05)	(0.06)	(0.07)	(0.14)	(0.09)	(0.11)
# Cloister, sqrd	-0.01	-0.02	-0.03	0.03	-0.00	-0.03
	(0.01)	(0.02)	(0.02)	(0.05)	(0.02)	(0.04)
# Schools $(0-10\text{km})$	0.02**	0.04***	0.03***	0.04*	0.03**	0.05**
	(0.01)	(0.01)	(0.01)	(0.03)	(0.01)	(0.02)
(ln) Distance to Cloister that existed betw. 1400 and 1500	0.02	0.03*	0.00	0.01	-0.04	0.07***
	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)	(0.02)
(ln) Distance to Higher Education School in Prussia	0.04**	0.01	0.02	0.00	0.02	0.01
	(0.02)	(0.02)	(0.02)	(0.04)	(0.03)	(0.03)
N	2037	2037	1443	594	975	1062
Weak Instrument Test†		11.17	13.35	3.07	10.33	4.78
Hansen J p-Value		0.94	0.67	0.11	0.37	0.20
Population Percentiles	✓	✓	✓	✓	✓	✓

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. *Source:* Own data collection and calculations. *Notes:* Cluster robust standard errors are in parentheses. †Kleibergen and Paap (2006) rank F-statistic for stationary data.

Table 2.15: Complete Long-run effects of Higher Education Schools on House Prices

	Dependent Variable: (ln) House Price					
Method	OLS	IV using Cloisters (1400-1500) and Prussian Schools				
Criteria			Highway and Railway		Highway	
Commuting Costs			Low	High	Low	High
	(1)	(2)	(3)	(4)	(5)	(6)
School	0.04***	0.29***	0.20**	0.67***	0.17*	0.32**
	(0.01)	(0.09)	(0.09)	(0.23)	(0.09)	(0.14)
(ln) Area in km^2	-0.03**	-0.02	0.02	-0.04	0.01	-0.06**
	(0.01)	(0.02)	(0.02)	(0.05)	(0.02)	(0.03)
(ln) Area Buildings in km^2 (1996)	-0.03	-0.02	-0.05**	0.03	-0.05*	0.02
	(0.02)	(0.03)	(0.03)	(0.04)	(0.03)	(0.03)
Population/Area	0.09**	0.01	0.10	-0.28	0.10	-0.12
	(0.04)	(0.07)	(0.07)	(0.21)	(0.07)	(0.10)
(ln) Population within 50km Distance	-0.02*	-0.06**	-0.02	-0.16*	-0.04	-0.04
	(0.01)	(0.03)	(0.02)	(0.09)	(0.03)	(0.03)
(ln) Population to Largest Population within 50km Distance	-0.02	-0.06**	-0.04**	-0.19*	-0.05	-0.05
	(0.01)	(0.03)	(0.02)	(0.10)	(0.03)	(0.04)
(ln) Distance to Highway (1937)	0.01	0.00	-0.00	-0.01	0.01	-0.01
	(0.01)	(0.01)	(0.01)	(0.03)	(0.01)	(0.02)
(ln) Distance to Railway (1890)	0.02***	0.02***	0.01	0.15***	0.01	0.03***
	(0.00)	(0.01)	(0.01)	(0.03)	(0.01)	(0.01)
(ln) Distance to City with more than 100.000 Inhabitants	-0.03**	-0.03**	-0.04***	0.01	-0.04**	-0.01
	(0.01)	(0.01)	(0.01)	(0.03)	(0.02)	(0.02)
(ln) Distance to City with more than 50.000 Inhabitants	-0.00	-0.00	-0.03**	0.07**	-0.02	0.03
	(0.01)	(0.01)	(0.01)	(0.03)	(0.02)	(0.02)
# Schools $(0 - 10\text{km})$	0.01***	0.01***	0.01***	0.04**	0.01***	0.02*
	(0.00)	(0.00)	(0.00)	(0.02)	(0.00)	(0.01)
# Cloister	0.05**	0.05**	-0.01	-0.00	-0.03	0.08**
	(0.02)	(0.02)	(0.02)	(0.07)	(0.02)	(0.04)
# Cloister, sqrd.	-0.01	-0.01*	-0.00	0.00	0.00	-0.01
	(0.00)	(0.01)	(0.00)	(0.02)	(0.00)	(0.01)
(ln) Distance to Cloister that existed betw. 1400 and 1500	0.03***	0.03***	-0.00	0.03*	-0.01	0.06***
	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)
(ln) Distance to Higher Education School in Prussia	-0.01	-0.02**	-0.01	-0.02	-0.00	-0.01
	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)
(ln) Amount of Land	0.14**	0.12*	0.20***	0.11	0.15*	0.12
	(0.06)	(0.07)	(0.07)	(0.12)	(0.09)	(0.09)
(ln) Amount of Living Space	0.71***	0.68***	0.78***	0.69***	0.71***	0.71***
	(0.09)	(0.09)	(0.10)	(0.18)	(0.12)	(0.13)
(ln) Land X (ln) Living Space	-0.01	-0.00	-0.02	-0.00	-0.00	-0.01
	(0.01)	(0.01)	(0.01)	(0.03)	(0.02)	(0.02)
Balcony	0.10***	0.10***	0.09***	0.13***	0.09***	0.12***
	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)
Garage	0.06***	0.06***	0.06***	0.06***	0.06***	0.06***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Basement	0.05***	0.05***	0.06***	0.05***	0.05***	0.07***
	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)
High Quality	0.19***	0.18***	0.17***	0.23***	0.16***	0.23***
	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)
Renovated	-0.06***	-0.06***	-0.05***	-0.09***	-0.05***	-0.09***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
In Need of Renovation	0.04***	0.04***	0.03***	0.06***	0.02*	0.06***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Renovated	0.00	0.00	0.00	0.00	0.00	0.00
	(.)	(.)	(.)	(.)	(.)	(.)
Newly Build	-0.04***	-0.03***	-0.05***	0.02	-0.06***	0.01
	(0.01)	(0.01)	(0.01)	(0.03)	(0.01)	(0.02)
Missing Construction Year	79.63***	79.44***	78.78***	79.75***	78.30***	81.45***
	(2.11)	(2.10)	(2.58)	(3.40)	(2.86)	(3.14)
(ln) Construction Year	10.51***	10.48***	10.39***	10.53***	10.33***	10.75***
	(0.28)	(0.28)	(0.34)	(0.45)	(0.38)	(0.41)
(ln) Mean Construction Year in Municipality	9.41***	9.55***	7.79***	11.62***	7.67***	10.11***
	(0.69)	(0.75)	(0.75)	(1.87)	(0.91)	(1.05)
(ln) # Number of Houses in Municipality	0.12***	0.12***	0.11***	0.12***	0.12***	0.12***
	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)
N	62072	62072	48010	14062	37960	24112
Weak Instrument Test†		16.85	13.30	4.67	8.38	11.89
Hansen J p-Value		0.19	0.45	0.62	0.57	0.92
Population Percentiles	✓	✓	✓	✓	✓	✓

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. *Source:* Own data collection and calculations. *Notes:* Cluster robust standard errors are in parentheses. †Kleibergen and Paap (2006) rank F-statistic for stationary data.

Chapter 3

Firm Foundation and Location Choices - The Effects of Public Good and Service Provision

Nadine Riedel* Martin Simmler† Christian Wittrock‡

Abstract

The aim of this paper is to determine the effect of public good and service provision (PIGS) on firm foundation and location choices. For that purpose, we make use of unique panel data on the birth, death and relocation of the universe of German firms and link it to information on local public good and service provision by German municipalities. Theoretical considerations predict a positive effect of PIGS provision on net firm foundation and firm location in the PIGS-providing municipality, while the effect on neighboring jurisdictions is ambiguous (related to a negative competition effect as firms relocate from the neighboring jurisdiction to the PIGS-providing entity and positive cross-border spillovers of PIGS benefits, which may increase foundation rates and relocation from more distant neighbors). On top, our theoretical model predicts a negative effect of corporate taxation in the considered locality and a positive effect of neighbors tax rate (supporting the hypothesis of dominating competition effects with respect to taxation) which is in line with the literature. We test these theoretical notions drawing on fixed effects Poisson models that absorb time constant heterogeneity in location and foundation rates across municipalities and industries. Our results suggest that aggregate PIGS spending exerts a positive effect on firm foundation and relocation in the PIGS-providing jurisdiction. On top, we find evidence in favor of a negative effect of local business taxes in the taxing municipality and competition effects between neighboring municipalities.

JEL Classification: D22, H4, H7, R30
Keywords: Firm Location; Firm Birth; Public Goods; Local Governments; Spatial Effects

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I. Introduction

The aim of this paper is to determine the effect of public good and service provision (PIGS) on firm foundation and location choices. A by now large empirical literature documents that low corporate tax rates are effective in attracting mobile firms and investments (see e.g. de Mooij and Ederveen 2003, Devereux and Maffini 2007, for surveys) and in inducing new firm foundations. Existing work, in turn, largely ignores that jurisdictions have a second set of policy instruments at hand to foster their attractiveness as a location for mobile capital: the provision of public goods and services. In particular, it may well be the case that firms are willing to accept high corporate tax rates if the revenues are used to fund PIGS that are beneficial for their operation (see Bénassy-Quéré *et al.* 2007).

In this paper, we assess the link between PIGS spending and firm location and foundation choices, exploiting a unique panel data on the birth, death and relocation of the universe of German firms linked to information on local public good and service provision by German municipalities. In line with the literature our theoretical considerations predict a negative effect of an increase in corporate taxation on the number of firm foundations or entries in the considered municipality and a positive effect in neighboring municipalities. The effect of PIGS provision on firm foundation and firm location in the PIGS-providing municipality is positive and ambiguous for neighboring jurisdictions. Specifically, the sign of the latter depends on the relative importance of a negative 'competition effect' (which reflects that firms have an incentive to relocate from neighboring jurisdictions to the PIGS-providing locality) and a positive 'spillover effect' (which reflects that benefits related to PIGS provision may spill-over on firms in neighboring jurisdictions, hence raising the neighbors' attractiveness as a host jurisdiction). Our empirical analysis will test for the latter by accounting for the spatial dimension of PIGS provision.

Methodologically, we will assess these theoretical notions drawing on fixed effects Poisson models, which absorb time constant heterogeneity in location and foundation rates across German municipalities. Guimarães *et al.* (2003) show that the estimates of a Poisson model can be interpreted as estimates of a conditional Logit model of firm foundation and are therefore suitable for empirical research considering location decisions. Moreover, Arauzo-Carod and Manjón-Antolín (2012) have shown that the Poisson model can be used to determine the effects of geographically distributed regressors.

PIGS provision by localities is modeled using detailed accounting data for German municipalities, where PIGS spending is translated in PIGS capital stocks applying the perpetual inventory method using operating lives provided by the federal statistical offices.[1] The data is furthermore augmented by information on municipalities' local business tax rates and socio-economic control variables (e.g. municipalities' population, and labor market characteristics). On top, we construct spatially weighted variables to account for spatial effects using a 'spatial lag of x' estimation strategy (see LeSage *et al.* 2009, for details).

To address potential endogeneity problems, we apply a control function approach where the PIGS capital stock and the tax rate is instrumented. The main results use two excluded instruments. PIGS spending is instrumented exploiting the variation in local business tax revenues generated by the 'Renewable Energy Sources Act' (RES Act) of 2000. This Act was initiated by the German state to promote energy production from renewable sources. Among others, the law created strong incentives for firms to construct wind power plants resulting in a substantial increase in the number of plants across Germany. As wind power plants are subject to local taxation, local business tax revenues of affected municipalities increased. Since wind power plants can, however, only be build in areas with sufficient wind strength and sufficient free/unpopulated space, the according information is used for the empirical identification. The local business tax rate is instrumented exploiting variation in a so-called reference tax for fiscal redistribution. Local tax revenues are collected on the federal state level and are partly (together with other revenues) redistributed

[1] The data e.g. allows us to differentiate between different spending categories, including e.g. infrastructure, schooling and recreation. This is a plus relative to previous work, which largely focuses on the effects of public infrastructure provision and derives a wide range of estimates due to non-trivial empirical identification problems (see e.g. Fisher 1997, Sturm *et al.* 1998, Romp and De Haan 2007).

across municipalities to mitigate imbalances in municipalities financial endowment. The reference tax (among other indicators) is used to calculate the potential taxable capacity of a municipality and to compare it with its actual tax revenues to determine the amount of redistributed revenues. Our instrument is a dummy indicating if the local business tax in 1998 was below or above the actual reference tax. If the reference tax exceeds (falls short from) the local business tax in 1998, local business tax rates are expected to have increased (fallen).

The empirical strategy is as follows. In a first step, we run simple ordinary least squares regressions of the provision of PIGS and the local business tax on our set of instruments and control variables. In a second step, the predicted residuals of these first stage regressions are included as regressors in the Poisson model for firm foundations and relocations to retrieve consistent estimates (see e.g. Wooldridge 2010, for details). The baseline regressions are augmented using spatially lagged variables weighted with inverse distance. Neighbors are defined as municipalities with centroids within 15km distance.[2] We use bootstrapping to obtain valid standard errors. Moreover, to correct for possible violations of the underlying Poisson distribution the bootstrapped standard errors are clustered on the municipality level. On top, we check for the robustness of our spatial regression using spatial weighting matrices generating an unweighted average over neighboring municipalities and weighting with inverse distance squared as well as population.

In line with our theoretical presumptions, our baseline results suggest that aggregate PIGS spending exerts a positive effect on firm foundation and relocation in the PIGS-providing jurisdiction, while local business taxation exerts a negative effect. The first stage results, moreover, confirm the relevance of our instrumental variables. The spatial regression results support the notion of positive effects of taxation on firm location and foundation rates in adjacent neighboring municipalities. Although we do not find significant effects of aggregate PIGS provision in neighboring mu-

[2]Our selection of the distance is based on recent work by Borck *et al.* (2015) who identify distances between 15km and 20km to generate the highest log-likelihood in Spatial-Durbin models of debt competition between German municipalities. To control for the robustness of our results we moreover estimate spatial models with a distance of 20km and 40km.

nicipalities, point estimates are in favor of spillover effects in close municipalities that turn negative with increasing distance. Using more specific PIGS proxies (e.g. spending directed towards families) depicts a positive effect of people goods on family intensive industries and significant point estimates for neighboring jurisdiction. The latter is in line with the notion of competition for mobile capital with respect to specific PIGS.

The rest of the article is structured as follows. Section II derives the underlying theoretical model. Section III describes the institutional background and the data. The empirical analysis is presented in Sections IV and V. Section VI concludes.

II. Theoretical Considerations

In this section, we develop a simple theoretical model to motivate our empirical approach. Consider a world with two municipalities $j = 1, 2$, which are located at the end points of a unit interval. We denote the location of municipality j by g_j and assume $g_1 = 0$ and $g_2 = 1$. There is a mass 1 of firms that are characterized by their location preferences. The bliss location point of firm k is denoted by x_k. We assume that bliss points are uniformly distributed over the unit interval. Firm owners decide in which locality to locate by maximizing their profit after mobility costs which relates to moving away from the bliss location. Mobility costs from locating in municipality j are denoted by $c\left(|x_k - g_j|\right) = c(\delta_k^j)$, where δ_k^j denotes the distance between firm k's location bliss point and municipality j and $c'(.) > 0$.[3]

Municipalities control two policy instruments that affect firm profits: the corporate income tax rate t_j and the level of public inputs, goods and services (PIGS). We assume that PIGS provision raises firm profits. This positive effect on corporate profitability may first relate to PIGS provision that directly increase firm productivity, e.g. related to publicly funded research and development centers. Al-

[3]Note that we implicitly assume that firms may not be able to locate in a municipality at the location of their bliss point. This may reflect that firm owners have a preference to locate their business in their home or residential municipality, which may, however, for business reasons (e.g. market access) not be a suitable business location.

ternatively, PIGS may help to lower input costs; infrastructure provision may lower transportation costs or PIGS directed towards households may imply that employees are willing to work for lower wages to enjoy the benefit from the regional amenities (e.g. recreation facilities, like parks or public swimming). To keep the model simple, we assume that only locality 2 provides PIGS.

The profit contribution of these PIGS to firms located in locality 2 is denoted by B_2. We further assume that the benefit from PIGS provision is not limited to firms located in locality 2 but that the PIGS provision may also have a positive impact B_1 on firms in neighboring locality 1. Roads in neighboring localities may e.g. also reduce transport costs (if they e.g. reduce traffic on the way to the next highway) or may benefit workers in neighboring jurisdictions who are then willing to work for lower wages. Plausibly, the contribution of PIGS to firm profits decreases with the distance to the municipality that provides the PIGS, i.e. firms located in municipality 1 plausibly benefit less from PIGS provision in 2 than firms located in locality 2, thus $B_2 \geq B_1$.

The profit net of mobility cost of firm k when it locates at municipality j is then

$$\begin{aligned} \pi_k^j &= (1-t_j)\left(V + B_k - \gamma c\left(\delta_k^j\right)\right) - (1-\gamma)c\left(\delta_k^j\right) \\ &= (1-t_j)\left(V + B_k\right) - (1-\gamma t_j)\, c\left(\delta_k^j\right), \end{aligned} \tag{3.1}$$

where V is a location independent component of profits that can be thought of capturing productivity and $0 < \gamma < 1$ denotes the fraction of mobility cost that are tax deductible. Each firm has to decide whether to enter and if so, in which municipality to locate. We first analyze the location choice assuming that the firm enters and then, in a second step, analyze the entry decision.

Location Choice

A firm with location bliss point x locates in municipality 1 if $\pi_k^1 - \pi_k^2 \equiv \Delta(x) \geq 0$, where

$$\Delta(x) = (t_2 - t_1) V + ((1 - t_1) B_1 - (1 - t_2) B_2) + (1 - \gamma t_2) c(1 - x) - (1 - \gamma t_1) c(x) \geq 0. \quad (3.2)$$

To rule out cases where all firms locate in one municipality, we assume that $c(1)$ is sufficiently high. The next lemma characterizes the optimal location decision conditional on entry.

LEMMA 1: *There exists a unique cutoff value $\overline{x}$ such that firms with location bliss point $x_k \leq \overline{x}$ locate at municipality 1 and firms with location bliss point $x_k > \overline{x}$ locate at municipality 2.*

How does $\overline{x}$ depend on the policy instruments available to municipalities? First note that, intuitively, both a lower value for t_1 and a higher value for t_2 raise $\Delta(x)$ implying that municipality 2 becomes a more attractive location choice.

LEMMA 2: *$\overline{x}$ decreases in t_1 and increases in t_2.*

Notice, however, that PIGS provision from municipality 2 may increase or decrease the attractiveness of municipality 1 relative to municipality 2. Locating at municipality 1 becomes more attractive if the net-of-tax benefit from PIGS in municipality 1, $(1 - t_1) B_1$ exceeds the net-of-tax benefit from PIGS in municipality 2, $(1 - t_2) B_2$, which can occur when t_1 is sufficiently smaller than t_2 or when the difference between B_1 and B_2 is small.[4] Conversely, municipality 2 becomes the more attractive location if t_1 is not too low and if $B_2 - B_1$ is large. This might be the case for PIGS directed to households like kindergartens or school improvements which can only be consumed if the household resides in the PIGS providing municipality.

LEMMA 3: *PIGS provision from municipality 2 shifts $\overline{x}$ to the right if $(1 - t_1) B_1 > (1 - t_2) B_2$ and to the left if $(1 - t_1) B_1 < (1 - t_2) B_2$.*

[4] Precisely, t_1 must be smaller than $\frac{t_2 B_2 - (B_2 - B_1)}{B_1}$

Entry Decision

To endogenize the number of firms that enter into the market, we assume that the location independent component of firm profits V is a random variable with distribution function $F(v)$.[5] A firm with bliss point $x \leq \overline{x}$ enters into municipality 1 if

$$\begin{aligned}(1-t_1)(V+B_1)-(1-\gamma t_1)\,c(x) \geq 0 \Longleftrightarrow \\ V \geq \frac{1-\gamma t_1}{1-t_1}c(x) - B_1 \equiv \overline{V}_1(x) - B_1.\end{aligned} \tag{3.3}$$

The total mass of firms locating at municipality 1 can now be calculated as

$$\int_0^{\overline{x}} \text{prob}\left(V \geq \overline{V}_1(x) - B_1\right) dx. \tag{3.4}$$

Analogously, a firm with location bliss point $x > \overline{x}$ enters into municipality 2 if

$$\begin{aligned}(1-t_2)(V+B_2)-(1-\gamma t_2)\,c\,(1-x) \geq 0 \Longleftrightarrow \\ V \geq \frac{1-\gamma t_2}{1-t_2}c\,(1-x) - B_2 \equiv \overline{V}_2(x) - B_2,\end{aligned} \tag{3.5}$$

yielding a total mass of entering firms of

$$\int_{\overline{x}}^{1} \text{prob}\left(V \geq \overline{V}_2(x) - B_2\right) dx. \tag{3.6}$$

Predictions

We now use the model to predict how changes in the corporate income tax rate and PIGS provision affect the number of firms in both municipalities.

Consider first an increase in t_2, which by equation (3.1) decreases profits of firms locating in municipality 2, while it leaves profits of firms locating in municipality 1

[5]Notice that we assume that the distribution of V is independent from the location bliss point.

unaffected. Moreover, by lemma 2 the increase in t_2 shifts $\overline{x}$ to the right. Hence, higher tax rates in municipality 2 unambiguously increase (decrease) the mass of firms in municipality 1 (2).

Next, we analyze how PIGS provision in municipality 2 affects the mass of firms in both municipalities. In the absence of PIGS provision, $B_1 = B_2 = 0$ and thus a firm with location bliss point x locates in municipality 1 if

$$\pi_k^1 - \pi_k^2 \equiv \Delta(x) = (t_2 - t_1)\, V + (1 - \gamma t_2)\, c\,(1 - x) - (1 - \gamma t_1)\, c(x) \geq 0$$

$$\text{and}$$

$$V \geq \overline{V}_1(x). \tag{3.7}$$

Setting $\Delta(x) = 0$ in the first line defines a cutoff value $\overline{x}_0$ below which firms locate in municipality 1. The mass of firms in municipality 1 in the absence of PIGS provision is then given by

$$\int_0^{\overline{x}_0} \text{prob}\left(V \geq \overline{V}_1(x)\right) dx, \tag{3.8}$$

while the mass of firms in municipality 2 is

$$\int_{\overline{x}_0}^{1} \text{prob}\left(V \geq \overline{V}_2(x)\right) dx. \tag{3.9}$$

We distinguish two cases. First, assume $(1 - t_2)\, B_2 \geq (1 - t_1)\, B_1$, i.e. the net-of-tax benefit from PIGS provision is higher in municipality 2. Thus, by lemma 3 PIGS provision increases the attractiveness of municipality 2 relative to municipality 1 leading to $\overline{x}_1 < \overline{x}$. PIGS provision then unambiguously increases the number of firms in municipality 2 because (i) the cutoff moves to the right, implying that given the entry decision of all firms, more firms locate in municipality 2 and (ii) firm profits increase through PIGS provision implying that entry goes up.

In contrast, PIGS provision has an ambiguous effect on the mass of firms in municipality 1. It shifts the cutoff location bliss point to the left, implying that given the entry decision of all firms, fewer firms will locate in municipality 1. However, firms at municipality 1 also benefit from the public good, implying that the incentives to enter the market go up. We can capture these effects formally by decomposing the entry probability into the probability that a firm enters into municipality 1 even without PIGS provision and the additional probability due to PIGS.

$$\begin{aligned} \text{prob}\left(V \geq \overline{V}_1(x) - B_1\right) &= \text{prob}\left(V \geq \overline{V}_1(x)\right) \\ &\quad + \text{prob}\left(\overline{V}_1(x) - B_1 \leq V \leq \overline{V}_1(x)\right). \end{aligned} \tag{3.10}$$

We can now write the entry probability at municipality 1 as

$$\begin{aligned} &\int_0^{\overline{x}} \text{prob}\left(V \geq \overline{V}_1(x) - B_1\right) dx = \\ &\int_0^{\overline{x}} \text{prob}\left(V \geq \overline{V}_1(x)\right) dx + \int_0^{\overline{x}} \text{prob}\left(\overline{V}_1(x) - B_1 \leq V \leq \overline{V}_1(x)\right) dx = \\ &\int_0^{\overline{x}_0} \text{prob}\left(V \geq \overline{V}_1(x)\right) dx + \int_{\overline{x}}^{\overline{x}_0} \text{prob}\left(V \geq \overline{V}_1(x)\right) dx + \\ &\int_0^{\overline{x}} \text{prob}\left(\overline{V}_1(x) - B_1 \leq V \leq \overline{V}_1(x)\right) dx. \end{aligned} \tag{3.11}$$

The first term is the mass of firms in municipality 1 without PIGS provision. The loss from the cutoff shift is captured by the second term $\int_{\overline{x}}^{\overline{x}_0} \text{prob}\left(V \geq \overline{V}_1(x)\right) dx$. The positive effect through higher entry incentives is captured by the third term $\int_0^{\overline{x}} \text{prob}\left(\overline{V}_1(x) - B_1 \leq V \leq \overline{V}_1(x)\right) dx$.

The predictions concerning the impact of PIGS provision on the mass of firms is reversed when the net-of-tax benefit from PIGS provision is higher in municipality 1. In this second case, municipality 1 unambiguously benefits from both the shift in the cutoff to the right and the increased entry incentives. The effect on municipality 2, which looses firms due to the cutoff shift but gains firms due to increased entry incentives is ambiguous, however.

Summarizing, the model makes the following predictions.

Prediction (Taxation and PIGS provision with entry and exit of firms)

1. Higher corporate tax rates in municipality j decrease (increase) the number of firms in municipality j (municipality $k \neq j$).

2. PIGS provision by locality j unambiguously increases the number of firms located in j and has an ambiguous effect on the number of firms in municipality $k \neq j$ if the net-of-tax benefit from PIGS is higher in municipality j and vice versa.

III. Institutional Background and Data

The empirical analysis to come will assess the effects of PIGS spending on the amount of firm foundations in West German municipalities. In the following, we describe the institutional background and the data set used for the empirical analysis.

A. Institutional Background

Municipalities in Germany are the lowest institutional legislative jurisdiction. They have self elected legislative governments, and have the right to solve any local matters autonomously (Article 28 of the German constitution). Localities generate income from two main sources. First, a fraction of the personal income tax and the value added tax revenue administered at the federal and state level are distributed to German municipalities based on fiscal rules. Municipalities may also receive special grants by higher government tiers. Secondly and importantly, localities have two (major) own revenue instruments at hand: first, they can autonomously set the local business tax rate, levied on business income earned within their borders and second, they choose the local property tax.[6] The majority of tax revenues from these two sources remains with the locality. Only a minor fraction is redistributed by fiscal equalization schemes. Note that the own tax revenue instruments generate a significant fraction of local income (on average about 20% in West German municipalities

[6]Note that Germany localities set two property taxes (A and B). Property Tax A is applied on land used for agricultural and forestry. Property Tax B is used for any other build-up property.

in 2006).[7]

German municipalities moreover provide various local public goods and services (PIGS), e.g. related to the construction and maintenance of roads, sewerage, kindergartens and primary schools. Further, municipalities have to provide social benefits to the unemployed and social welfare recipients. Additionally, public goods and services related to culture and sport facilities, tourism, and public transport may be provided. Note that while some expenditures are mandatory, including administration, social security and financing liabilities, others are optional, including e.g. spending for theaters, youth centers, the promotion of science, health care, sport and recreation facilities. Hence, this voluntary expenditures are part of the policy set of municipalities to attract mobile capital and households.

B. Data

In what follows we will use combined data from various sources for German municipalities.[8] For the number of firm foundations in German municipalities, we will use the total number of newly registered corporate enterprises, partnerships and self-employed people (full time and with at least 1 employee) drawn from the *Gewerbeanzeigenstatistik*.[9] The registration of a new branch will be counted as a new foundation. By law, firms are mandatory to register.[10] Figure (3.1) shows a histogram of the number of firm foundations in our sample in 2001.[11] We will drop municipalities with a population greater 300,000 to exclude dominant cities (like

[7]Calculations are based on our sample.

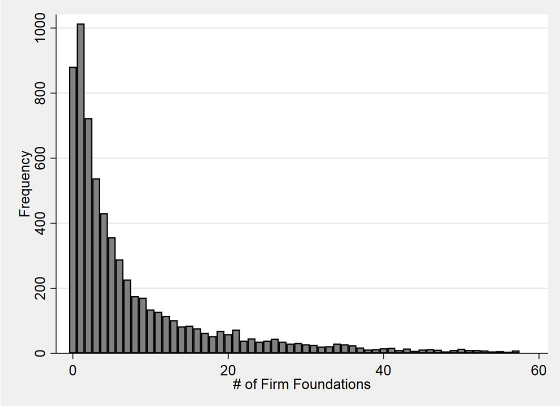
[8]Institutional reforms change the German municipality landscape every year due to mergers and separation. We will use the institutional setting at December 31st, 2006 as our common identifier to merge data sets. To calculate the values for every municipality and every year as if the municipality existed at the beginning of 2007 we use publicly available information on mergers and separations. For example, if two municipalities in 2005 joined in 2006 their expenditures for 2005 are calculated taking the sum of their separate values.

[9]Taking only the number of corporate enterprises as our dependent variable does not change the results.

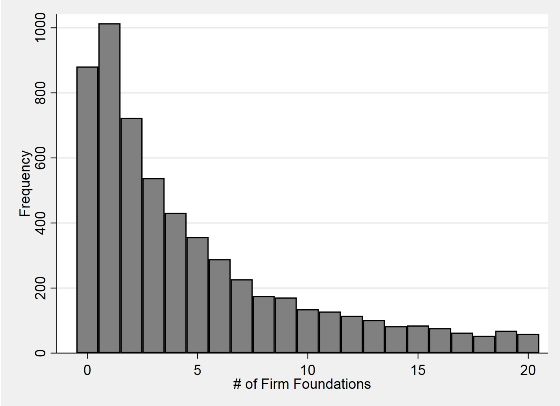
[10]Note that the *Gewerbeanzeigenstatistik* also includes self-employed firms. Our sample of firm foundations does include all registrations of corporations, partnerships and self-employed firms with at least 1 employee.

[11]The figure is based on a sample of municipalities with a number of firm foundations less/equal to the 95% quantile of (or 20) firm foundations in 2001.

Figure 3.1: Histogram of Firm Foundations in 2001



(a) Cut off at the 95% Quantile.



(b) Maximum of 20 Foundations.

Notes: The figure depicts the aggregate number of firm foundations in West German municipalities in 2001. For the illustration in figure (a) we drop firm foundations above the 95% quantile.

Munich) that act as outliers in the data.[12] Our data consists of approximately 8,130 municipalities. Figure (3.1b) shows that a high share of municipalities (almost 11%) had no firm foundation in 2001. Hence, to control for possible violations of equidispersion in the Poisson distribution we use cluster robust standard errors on the municipality level (see Wooldridge 2010). Clustering allows us to draw conclusions about inference even if the underlying Poisson assumptions are violated.

To calculate the value of the PIGS capital stock we will use detailed disaggregated accounting data of German municipalities between 1992 and 2006. Namely, the *Jahresrechnungsstatistik* allows us to construct proxies for investment and depreciation of different spending categories. This spending categories cover (among others) expenditures for construction and asset investment for public security, schools, public education and culture, child and youth care, recreation and sports, infrastructure, housing and economic promotion. We will apply the perpetual inventory method to generate stock values. To do so, we calculate the initial stock value K_0 using expenditure information for the pre-sample periods 1992 to 1997 with

$$K_0 = \frac{\overline{EXP}}{g_{gdp} + \frac{1}{T}}. \tag{3.12}$$

[12]Moreover, we exclude city-states (Bremen and Hamburg) from the analysis.

where $\overline{EXP}$ stands for mean PIGS expenditures between 1992 and 1997, g_{gdp} for the GDP growth rate and T for the average operating life. Note that we will assume a GDP growth rate of 2%.

We assume linear depreciation of the initial capital stock. Depreciation rates are calculated using publicly available information about operating lives. Investment is represented by capital expenditures for a specific PIGS category in every year. Additionally, we add administration expenditures in every year, but assume 100% depreciation of the latter within one year. Hence, the PIGS capital stock $C_{j,i,t}$ of asset j in municipality i at time t is given by

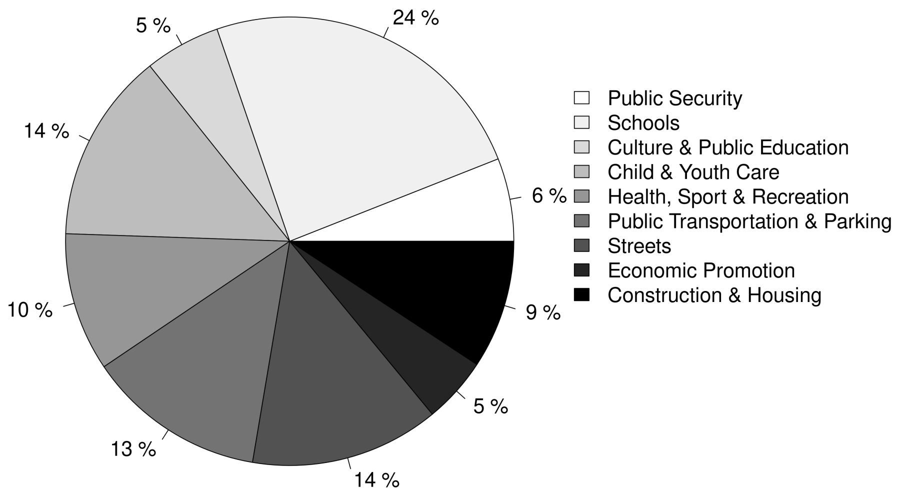
$$C_{j,i,t} = \sum_{k=0}^{T_j} EXP_{j,i,t-k}\left(1 - \frac{k}{T_j}\right) + ADM_{j,i,t} \tag{3.13}$$

with $EXP_{j,i,t}$ capital expenditures, $ADM_{j,i,t}$ administration expenditures and T_j the average operating life of asset category j. We assume that the expenditures in 1992 (the starting year of our data) are equal to the capital expenditures plus the initial capital stock K_0. Hence, expenditures before 1992 are assumed to be equal to 0. We construct a total capital stock by aggregating over all asset categories.[13] Figure (3.2) depicts the average shares of all PIGS categories relative to the total capital stock in 2006. The majority of the PIGS stock of German municipalities is associated with schools while the second highest covers child- and youth care or streets respectively. In the analysis to come we will split the total capital stock in three subcategories (1) *People Goods*, (2) *(Municipality) Streets* and (3) *Economic Promotion* to asses the impact of specific PIGS on firm foundations.[14]

[13] To assess the robustness of our results with respect to our definition of the total capital stock we reestimate the control function specification with spatially lagged variables using overall current (voluntary) expenditures.

[14] The subcategory people goods comprises of expenditures for (a) schools, (b) culture and public education, (c) child- and youth care, (d) health, sport and recreation, (e) public transportation and parking. In the analysis we will control for the difference of the total capital stock and the subcategories of interest to capture the effects of possible shifts in public expenditures. We will refer to this residual category as *Other Stock*. Note that *Streets* covers only expenditures for municipality and county streets. While the responsibility for public streets is shared among all German institutions, expenditures for streets that cross multiple institutional boundaries, e.g. highways, are mainly the responsibility of the federal states or German government.

Figure 3.2: Average Shares of PIGS Categories in 2006



We further augment our data with information about the local business tax and socio-economic variables for each municipality provided by various statistics.[15] The latter contains information about the population in 1000, the unemployment rate, the share of low, medium and high skilled workers and the number of students (per 1000 inhabitants) and doctors (per 100,000 inhabitants).[16] We will use information on the full set of German firms provided by the Institute for Employment Research and the DAFNE data set to split firm foundations of different industry classes with respect to the intensity of specific inputs or their output product.[17] To asses the impact of *People Goods* on firm foundations we will define *Family Intensive Industries* as industries with an average share of employees aged 35 to 49 above the median share over all industries. Furthermore, to assess the impact of streets we define industries as *Transport Intensive* if their share of sold goods relative to heavy input factors that need transportation is above the median of all industries.[18] Note that

[15]Note that the tax rate is represented by a tax multiplier in points.

[16]Note that the share of workers, the number of students and the number of doctors are based on county level information.

[17]The DAFNE data set is provided by Bureau van Dijk.

[18]We control for the robustness of our splitting using a split at the 75% Quantile for both *Family* and *Transport Intensive Industries*.

both data sets are not available on the municipality level. Therefore, we are not able to control for the stock of existing firms in our analysis.

Table (3.1) depicts the descriptive statistics of our sample. The average municipality has 6,700 inhabitants with an average capital stock of 30.44 Million Euro. The average number of firm foundations in our sample is 11. Note that the variation of PIGS provision among municipalities is high.

Table 3.1: Descriptive Statistics

	Mean	Std. Dev.	Pctl(25)	Pctl(75)
# of Firm Foundations	10.65	32.32	0.00	8.00
Population in 1,000	6.71	16.79	0.82	6.02
Unemployment Rate in %	5.35	1.82	4.00	6.40
Share of Low Skilled Workers in %	17.55	2.97	15.20	19.70
Share of Medium Skilled Workers in %	63.29	3.75	60.60	65.90
Share of High Skilled Workers in %	5.61	2.30	4.20	6.20
Students per 1,000 Inhabitants	5.18	14.98	0.00	3.20
Doctors per 100,000 Inhabitants	131.93	22.84	121.40	139.20
Local Business Tax Multiplier	339.02	31.12	320.00	352.00
Total Capital Stock in 1M Euro	30.44	68.40	3.59	30.35
Voluntary Stock in 1M Euro	25.82	57.80	3.03	25.48
People Goods in 1M Euro	20.12	46.15	2.03	19.84
Streets in 1M Euro	4.24	12.26	0.52	3.56
Economic Promotion in 1M Euro	1.46	6.07	0.06	0.81
Other Stock in 1M Euro	4.62	12.65	0.28	3.71
Total Capital Stock per Capita	5,139.12	2,327.23	3,672.67	6,083.29
Average Wind Strength in 80 Meter Height	5.52	0.72	5.00	5.96
Agricultural Land in km^2	15.52	18.08	4.14	19.53
Observations	8130			

Source: Own data collection and calculations. *Notes:* Calculations are based on the year 2006 and include 8,130 municipalities. The number of firm foundations represent the aggregate of foundations over all industries. Voluntary spending is the sum of *People Goods*, *Streets* and *Economic Promotion*. Expenditure per Capita are based on the population in the pre-sample year 1997. Average wind strength lies between 0 (no wind) and 10 (hurricane).

IV. Estimating Firm Foundation

A. *Baseline Estimation*

Most empirical studies use explanatory variables measured at the locality of interest and assume that the effects are restricted to the geographical area defined by the institutional setting (Arauzo-Carod and Manjón-Antolín 2012). This assumption is in stark contrast to the literature on "new economic geography" (Fujita *et al.* 1999, Combes *et al.* 2008). As demonstrated in our theoretical motivation spillover or competition effects between municipalities are likely to occur. Therefore, we will control for spatial variation of our explanatory variables to assess the effects of neighborhood on firm foundations in more detail. However, spatial dependence between expenditures and policy sets of German municipalities, as shown by Borck *et al.* (2007, 2015), complicates our empirical analysis. Thus, before integrating a spatial dimension into the analysis we will start with a simple Poisson estimation to assess the effects of taxation and PIGS provision in the considered municipality neglecting spatial correlation. The baseline strategy reads

$$E\left(y_{it}|\mathbf{X}_i, C_{it}, T_{it}, \lambda_i, \delta_t\right) = \exp\left(\gamma \mathbf{X}_i + \beta_1 C_{it} + \beta_2 T_{it} + \lambda_i + \delta_t\right) \tag{3.14}$$

with y_{it} the number of firm foundations, C_{it} the value of the total capital stock, T_{it} the local business tax and $\mathbf{X}_i$ a vector of socio-economic controls in municipality i at time t. Additionally, we will control for municipality fixed effects λ_i and time fixed effects δ_t. Socio-economic controls are population in 1000, the unemployment rate, the share of low, medium and high skilled workers and the number of students as well as doctors. All regressions include cluster robust standard errors on the municipality level to allow for deviations from the Poisson distribution (see Wooldridge 2010).

As mentioned, the baseline regressions do not include spatial effects. Based on our theory, we expect β_1 to have a positive coefficient as firms are attracted by higher provision of public inputs, goods and services. Further, the effect of taxation on firms' location choices β_2 should give a negative point estimate (see e.g. de Mooij and Ederveen 2003, Devereux *et al.* 2007 for surveys). The coefficients of a Poisson regression can be interpreted as semielasticies (Cameron and Trivedi 2005). Calculus shows for a one unit change of the local business tax rate that[19]

$$\frac{\partial E\left(y_{it}|\mathbf{R}_{it}\right)}{\partial T_{it}} = \exp\left(\gamma \mathbf{X}_i + \beta_1 B_{it} + \beta_2 T_{it} + \lambda_i + \delta_t\right) \times \beta_2 = E\left(y_{it}|\mathbf{R}_{it}\right) \times \beta_2. \tag{3.15}$$

[19] $\mathbf{R}_{it} = \{\mathbf{X}_i, B_{it}, T_{it}, \lambda_i, \delta_t\}$ represents our set of regressors.

This can also be interpreted as a proportional change since

$$\frac{\partial E\left(y_{it}|\mathbf{R}_{it}\right)/E\left(y_{it}|\mathbf{R}_{it}\right)}{\partial T_{it}} = \beta_2 \tag{3.16}$$

Columns (1) to (3) of Table (3.2) depict the results of the baseline regression with control variables. Specification (1) depicts the point estimate including only the local business tax rate in the regression. The point estimate of -0.001 is significant at the 5% level. Hence, a 10% increase of the mean local business tax rate leads to a proportional decrease of the expected count of firm foundations by 3.39% ($33.9 \times 0.1\%$). Specification (2) uses the Total Capital Stock and depicts a positive and significant point estimate of 0.0014. Thus, a 10% increase of the mean Total Capital Stock results in a small proportional increase of firm foundations by 0.43% ($3.044 \times 0.14\%$). Combining both the tax rate and our proxy for the total capital stock in one regression (see specification (3)) gives similar results. Hence, using a simple Poisson regression to capture the effects of tax rates and expenditures for PIGS on the number of firm foundations generates significant but small point estimates.

Table 3.2: Baseline Poisson Regressions

	Poisson (1)	Poisson (2)	Poisson (3)
Local Business Tax	-0.0010**		-0.0009*
	(0.0005)		(0.0005)
Total Capital Stock		0.0014***	0.0013**
		(0.0005)	(0.0005)
N	70653	70653	70653
log likelihood	-128812.14	-128780.50	-128761.58
chi.squared	1913.99***	1984.39***	1979.35***
Year Fixed Effects	✓	✓	✓
Municipality Fixed Effects	✓	✓	✓
State X Year Fixed Effects	✓	✓	✓
Controls	✓	✓	✓

*$p < 0.10$, **$p < 0.05$, **$p < 0.01$. *Source:* Own data collection and calculations. *Notes:* The Total Capital Stock is expressed in 1 Million Euro. Full estimation tables including the control variables can be found in appendix D. Robust clustered standard errors in parentheses.

Using simple Poisson regressions to estimate the effects of taxation and PIGS spending on firm foundation might create simultaneity bias due to endogenous regressors. Following Brülhart *et al.* (2012) the local stock of firms has an impact on the local tax rate through the local tax base. The same applies to the level of public spending as this is determined by the level of public revenues which is directly connected to local tax rates. Furthermore, the number of firms might directly influence political decisions in the local council. Note that the latter is mitigated by using new firm foundations which are unlikely to have the same impact on taxation and spending as existing firms. However, to relax concerns on reversed causality we implement a control function approach to instrument the local business tax rate and PIGS provision.

B. Control Function Approach with Spatial Effects

In what follows, we will apply a control function approach to address the problem of endogeneity faced in our baseline regression. The control function approach reads

First Stage:

$$C_{it} = \gamma_1 \mathbf{X}_{it} + \gamma_2 \mathbf{Z}_{it} + \lambda_i + \delta_t + \nu_{it}$$

$$T_{it} = \gamma_1 \mathbf{X}_{it} + \gamma_2 \mathbf{Z}_{it} + \lambda_i + \delta_t + \mu_{it}$$

Second Stage:

$$E[y_{it}|\mathbf{R}_{it}] = exp\left(\gamma \mathbf{X}_{it} + \beta_1 C_{it} + \beta_2 T_{it} + \lambda_i + \delta_t + \nu_{it} + \mu_{it}\right) \quad (3.17)$$

with ν_{it} and μ_{it} the predicted residuals calculated from regressing C_{it} and T_{it} on our socio-economic controls, controls for the instruments $\mathbf{X}_{it}$ and the excluded instruments $\mathbf{Z}_{it}$ using ordinary least squares. Standard errors are bootstrapped with 100 draws to obtain valid standard errors when instrumenting the capital stock and tax rate.

Based on our theoretical framework we expect spatial effects of PIGS provision and taxation. We therefore expect the (instrumented) spatially lagged capital stock and the (instrumented) spatially lagged tax rate to have a significant effect on the count of firm foundations. To address the concerns of spatial dependence we will use control functions for every spatially lagged variable using spatially lagged instruments.

To construct spatial variables we define a spatial weighting matrix W for neighbors within 15km distance.[20] As has been demonstrated by Borck *et al.* (2015) using a 15km distance is suitable for the empirical analysis of German municipalities. The spatial weighting matrix is created following the general notion. Assuming N to be the total number of municipalities in our sample we construct an $N \times N$ matrix with zeros on its diagonal. Values of the matrix take the inverse distance between municipalities if municipalities are neighbors. Lastly, the matrix will be row-standardized such that the weights add up to 1. Appendix B will present results if we alter the definition of our spatial weighting matrix using 20km and 40km distances. Moreover, we assess the robustness of our spatial weighting matrix using inverse distance squared and population weights as well as an unweighted average of neighbors observations.

C. Instruments

We will instrument the capital stock using two main instruments.

The first exploits variation generated by the 'Renewable Energy Sources Act' (RES Act) of 2000. This Act was initiated by the German state to promote energy production from renewable sources. Among others, the law created heavy subsidies for firms constructing wind power plants resulting in a substantial increase in the number of plants across Germany. Wind power plants are subject to local taxation and directly increase local trade tax and property tax revenues. Note that to maximize energy output wind power plants are build in areas with high wind strength and sufficient free/unpopulated space. The guideline for approving the construction of wind power plants in Germany states that the typical distance of an energy production area with 7 wind power plants from the next local town should be at least 1500 meters.

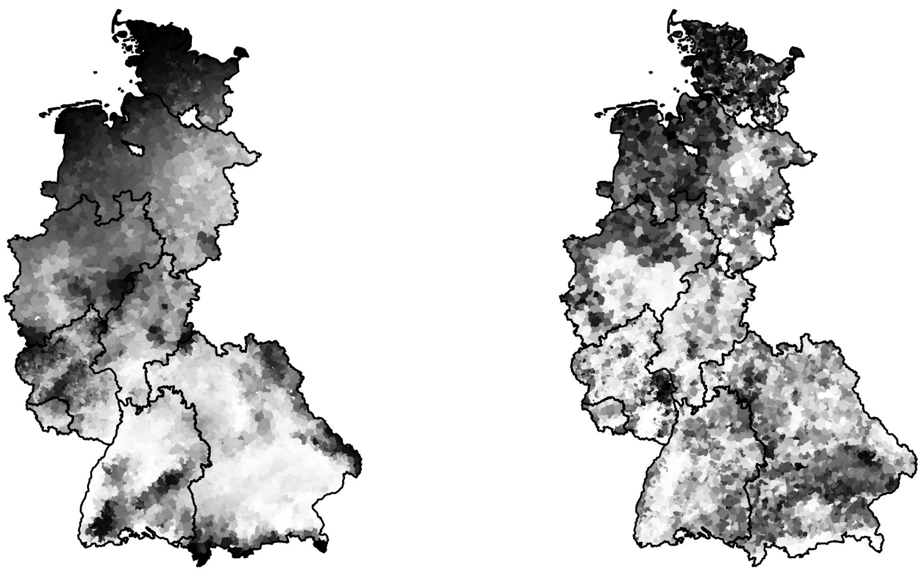
To construct the instrument we will use the mean wind strength (from 1981 to 2000) in a height of 80 meters and the total agricultural land in km^2 within German

[20]Distance is measured as the Great-Circle distance between municipality centroids.

municipalities. Figure (3.3) depicts 1% quantiles of all three variables. Darker colors are associated with higher quantiles. The figure suggests that wind strength and agricultural land vary substantially between localities. The figures imply that localities in the north of West Germany (especially in Lower-Saxony and Schleswig-Holstein) are more likely to host wind power plants due to higher wind strength and sufficient agricultural land. To construct the instrument, the two variables (wind and agricultural land) are multiplied with a dummy taking the value 1 after the year 2000. Further we construct the interactions between both variables. We expect municipalities with suitable wind power and agricultural land to have benefited from the renewable energy sources act. Hence, the two-way interaction serves as our instrument while we control for mean wind strength. Additionally, the instrument is multiplied with a time trend to capture delayed effects.

Figure 3.3: Quantiles of Mean Wind Strength in 80 Meters Height and Mean Share of Agricultural Land

(a) Mean Wind Strength in 80m Height (b) Mean Share of Agricultural Land



Notes: The figure depicts the 1% quantiles of wind strength in 80m height and the share of agricultural land in West Germany in 2006.(federal states are outlined with black lines). Darker colors are associated with higher quantiles. There exists a clear difference between North and South Germany with more wind and agricultural land in Lower Saxony and Schleswig-Holstein. To address concerns about the differences between federal states we include state times year fixed effects in the regressions.

The tax factor of the trade tax is instrumented using a dummy indicating derivations from a so-called reference tax. Local business tax revenues are collected on the federal state level and are partly (together with other revenues) redistributed across municipalities. The reference tax is used to calculate the potential taxable capacity of a municipality and to compare it with its actual tax revenues to determine the amount of redistributed tax revenues. Our instrument is a dummy indicating if the local business tax in 1998 was below or above the actual reference tax. If the reference tax exceeds (falls short from) the trade tax in 1998, local business tax rates are expected to have increased (fallen).

We control for the robustness of our the instruments by adding state times year fixed effects to validate if variation within states and years of the dummy is sufficient to instrument the trade tax rate and to capture systematic differences between federal states in terms of wind strength and agricultural land.[21]

D. Control Function Results

Table (3.3) depicts the results of the second stage. First Stage results for specification (4) are presented in Table (3.5) in Appendix A.[22] The signs of our instruments are as expected. An increase of mean wind strength and agricultural land increases the capital stock (through higher revenues). Municipalities with a higher reference

[21] Note that we control for the robustness of our results using other instruments (results are not reported). First, we instrumented the local business tax rate with firm size shocks. Empirical evidence shows that municipalities with a stock of large firms tend to have smaller business tax rates. Our instrument is an index representing the average firm size and concentration (Herfindahl Index) within municipalities based on Bureau van Dijk's AMADEUS data. The instrument gives comparable results for municipalities with more than 2,000 inhabitants. Though, results for a sample including small municipalities gives unexpected first stage results. Moreover, we check for the robustness of the *Wind* instrument replacing wind strength with corn harvest within municipalities. The instruments follows the same idea as corn harvest can be used for bio-energy production and was heavily subsidized by the RES Act. On top, corn production requires substantially larger agricultural land compared with wind energy production supplanting free land for private housing construction. Hence, the RES Act led to an increase in land prices within municipalities and generated additional property tax revenues. Using corn harvest does not significantly alter the results.

[22] Note that the first stage results do not significantly change between specifications.

tax rate as their local business tax rate in 1998 increased the latter.

Table 3.3: Control Function Poisson Regressions

	CF (1)	CF (2)	CF (3)	CF (4)
Local Business Tax	-0.0083***		-0.0084***	-0.0137**
	(0.0019)		(0.0021)	(0.0055)
(0-15) Local Business Tax				0.0188***
				(0.0065)
Total Capital Stock		0.0199**	0.0120	0.0257***
		(0.0086)	(0.0081)	(0.0086)
(0-15) Total Capital Stock				0.0327
				(0.0273)
N	70653	70653	70653	70653
Year Fixed Effects	✓	✓	✓	✓
Municipality Fixed Effects	✓	✓	✓	✓
State X Year Fixed Effects	✓	✓	✓	✓
Controls	✓	✓	✓	✓
Bootstraped SE	✓	✓	✓	✓
# Bootstraps	100	100	100	100

*$p < 0.10$, **$p < 0.05$, **$p < 0.01$. *Source:* Own data collection and calculations. *Notes:* The Total Capital Stock is expressed in 1 Million Euro. Full estimation tables including the control variables can be found in appendix D. Bootstrapped and clustered standard errors in parentheses.

The point estimates for the local business tax rate as well as the total capital stock increase substantially (approximately by the magnitude 10) using our instrumental variable framework. Hence, a 1% increase in the (mean) local business tax rate decreases the expected number of firm foundations proportional by around 2.8%. An increase in (mean) public spending by 1% increases the expected number of new firms proportional by around 0.61%. Combining both the local business tax rate and the total capital stock in one regression (see specification (3)) does not significantly change the point estimate for the local business tax rate. However, the point estimate for the capital stock decreases and is insignificant. Note that our instrument for public spending is based on the assumption that the RES Act generated additional revenues through higher business tax revenues in municipalities that benefited from high wind strength and large agricultural land. Thus, it is not unreasonable that the instrument also captures variation in the local business tax rate induced by the RES Act.

Including spatially lagged variables increases the point estimate for the local business tax rate and the total capital stock. Both are significant when including spatial lags of our instruments. An increase in the (mean) local business tax rate by 1% results in a proportional decrease of the number of new firm foundations by around

4.5% (which is comparable to the estimates found by Brülhart *et al.* 2012, for firms without strong localization). An increase of the (mean) total capital stock by 1% increases firm foundations proportionally by around 0.8%. The spatial local business tax rate is positive and significant. Hence, an increase in the (mean) local business tax rate of neighboring municipalities within 15km distance by 1% would increase the number of firm foundations by 6.37%.[23] These results are in line with our theoretical predictions in favor of dominating competition effects with respect to corporate taxation. We are not able to identify a significant effect of the spatially lagged total capital stock. The point estimate is positive but insignificant. Thus, although we can not neglect the hypotheses that the point estimate is zero, a positive point estimate would imply spillover effects between neighboring municipalities.

E. Robustness Checks

We control for the robustness of our results altering our main specification (4) of Table (3.3). The results are depicted in Table (3.6) in Appendix B. Increasing the distance for our definition of neighbors to 20km and 40km shows that while the tax rate effect of the considered municipality stays negative and significant it decreases with distance. Moreover, we do find a significant competition effect for neighbors tax rate that disappears and turns insignificant at 40km distance. Results for the total capital stock for 20km distance support previous findings. We identify a positive and significant effect of 0.0223 for the considered municipality and a positive but insignificant effect for neighboring municipalities. Using 40km distance the effect in the PIGS providing municipality decreases to 0.0154. On top, the point estimate for neighbors turns negative. The latter supports the assumption of competition effects between more distant municipalities.

Although by using PIGS provision per capita (see specification (3)) the point estimates for the local business tax rate and spatially lagged tax rate increase, the

[23]Calculations are based on the assumption of a mean local business tax rate in neighboring municipalities of 339 points.

general implications are still valid. However, the point estimate for total capital stock per capita is positive and insignificant. This is based on the fact that the value per capita does not adequately capture size differences between municipalities in the provision of PIGS that can explain the variation in the number of firm foundations.

Using our baseline specification and replacing the total capital stock with overall voluntary expenditures (see specification (4)) gives comparable results.[24] Note that the point estimate for the local business tax rate is smaller and imprecisely estimated. Splitting the total capital stock in voluntary capital stock (the sum of people goods, streets and economic promotion) and a residual category (see specification (5)) does not alter the estimate for the local business tax rate. Moreover, the capital stock for people goods, streets and economic promotion has a positive and significant effect on the expected number of firm foundations with a magnitude comparable to the total capital stock. Although splitting the voluntary capital stock even further (see specification (6)) produces insignificant point estimates, we identify a strong effect of economic promotion on the expected number of firm foundations.

Constructing spatial variables using a simple average of neighbors or inverse distance squared does not substantially change our results.[25] We find a negative effect of the local tax rate and a positive effect of neighbors tax rate. On top, PIGS provision has a positive effect in the providing municipality. The effect for neighbors stays insignificant. Using population weighted spatial variables decreases the point estimates substantially. While the tax effect stays negative and significant we are not able to identify a significant effect of spatial tax rates or PIGS provision.

We control for size differences in every regression. Nevertheless, outliers may distort our results. The latter is addressed by winsorizing the sample and dropping federal states.[26] This robustness check serves as an ad-hoc jackknife analysis to explicitly control for differences between states that might bias the results. Neither of these two

[24]Voluntary expenditures are defined as current overall expenditures minus expenditures for administration and social welfare.
[25]Results are depicted in Tables (3.7) to (3.9) in Appendix B.
[26]Results are not reported.

procedures change the results significantly. Hence, we can conclude that our results are not sensitive to outliers or different federal environments in West Germany.

V. The Effect of PIGS on Family and Transport Intensive Industries

Section IV uses the total capital stock as our proxy for PIGS. The existing literature (see e.g Fisher 1997, Sturm *et al.* 1998, Romp and De Haan 2007) has mostly relied on infrastructure investment and tax rates as the only determinants of firm foundation. Our data allows us to test for the effects of a variety of assets. As outlined above we use three different subcategories of PIGS spending namely (1) people goods, (2) streets and (3) economic promotion to test for the effects on different firm types. To instrument the subcategories we weight our wind instrument with the share of the respective PIGS category in 1997 relative to the total capital stock in 1997.

Table 3.4: Family and Transport Intensive Industries

	Median		Pctl(75)		Median		Pctl(75)	
	Family Intensive Industries				Transport Intensive Industries			
	Yes (1)	No (2)	Yes (3)	No (4)	Yes (5)	No (6)	Yes (7)	No (8)
Tax	-0.0120	-0.0138**	-0.0092	-0.0135**	-0.0162***	-0.0140*	-0.0177***	-0.0142***
	(0.0099)	(0.0059)	(0.0257)	(0.0059)	(0.0041)	(0.0079)	(0.0066)	(0.0049)
(0-15) Tax	0.0115	0.0176***	0.0170	0.0172**	0.0163***	0.0164*	0.0189**	0.0153**
	(0.0122)	(0.0068)	(0.0330)	(0.0072)	(0.0063)	(0.0087)	(0.0080)	(0.0071)
People Goods	0.0575***	0.0101	0.1159**	0.0122				
	(0.0205)	(0.0113)	(0.0517)	(0.0116)				
(0-15) People Goods	-0.0815*	0.0490*	-0.2884***	0.0449*				
	(0.0427)	(0.0272)	(0.1062)	(0.0263)				
Streets					0.0143	0.0178	0.0163	0.0151
					(0.0094)	(0.0110)	(0.0118)	(0.0107)
(0-15) Streets					-0.0457	0.0145	-0.0352	-0.0139
					(0.0441)	(0.0539)	(0.0564)	(0.0564)
Other Stock	0.0489***	0.0135	0.0987**	0.0154	0.0177**	0.0212*	0.0205*	0.0191*
	(0.0180)	(0.0094)	(0.0450)	(0.0106)	(0.0090)	(0.0113)	(0.0117)	(0.0103)
(0-15) Other Stock	-0.0486	0.0273	-0.1386	0.0251	-0.0116	0.0278	-0.0133	0.0153
	(0.0365)	(0.0226)	(0.0955)	(0.0246)	(0.0293)	(0.0363)	(0.0344)	(0.0352)
N	54525	70254	34143	70522	68838	66344	63563	69517
Controls	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓
Municipality FE	✓	✓	✓	✓	✓	✓	✓	✓
State X Year FE	✓	✓	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓	✓	✓
Bootstraped SE	✓	✓	✓	✓	✓	✓	✓	✓
# Bootstraps	100	100	100	100	100	100	100	100

*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$. *Source:* Own data collection and calculations. *Notes:* Other Stock is the difference between Total Capital Stock and the sum of voluntary spending in each specification. Bootstrapped and clustered standard errors in parentheses. Tax: Local Business Tax

Specifications (1) to (4) of Table (3.4) depict the results for *Family Intensive Industries* and specifications (5) to (8) the results for *Transport Intensive Industries.* We assume that *Family Intensive Industries* who are strongly dependent on employees aged 35 to 49 are more willing to locate in municipalities with higher provision of PIGS targeted for people as it generates easier access to this specific work force.

Moreover, we assume that industries that are more transport intensive and have a high ratio of sold goods to heavy material inputs need cheap access to transportation. Hence, firm foundations of *Transport Intensive Industries* should be more sensitive to the provision of public streets. We moreover regress our full set of PIGS categories on our sample splits to assess the importance of economic promotion.[27]

Comparing specifications (1) and (2) of firms that are family intensive with firms that are not (splitting the sample at the median share of employees aged 35 to 49) supports the first assumption. We find evidence that *Family Intensive Industries* are significantly positively affected by higher spending for people goods with a point estimate of 0.0575. Hence, an increase of the average provision of people goods by 1% increase the expected number of firm foundations in *Family Intensive Industries* proportional by approximately 1.16%. On top, we identify a significant positive point estimate of the residual category of 0.0493. Note that the point estimates for the tax rate and the spatial tax rate are insignificant. On top, the point estimate for neighbors PIGS provision is negative and significant of magnitude 0.0815. Hence, an increase in the average provision of people goods in neighboring municipalities decreases the expected number of firm foundations in the considered municipality by approximately 1.64%.[28] In contrast, we do not find significant effects of the provision of people goods for *Non-Family Intensive Industries* but a negative and significant effect of local business taxes and a positive and significant effect of the spatially lagged tax rate of neighboring municipalities. Note that specification (2) also depicts a positive and significant effect of spending for people goods in neighboring municipalities. Specifications (3) and (4) use a sample split at the 75% quantile and support the previous results. On top, *Family Intensive Industries* defined at the 75% quantile are stronger affected by the provision of people goods with a 1% increase in the average provision of people goods increasing the expected number of firm foundations in *Family Intensive Industries* by approximately 2.33%. Using the full set of PIGS categories (see specifications (1) to (4) in Table (3.10)) supports

[27]Results are reported in Appendix C.

[28]Calculations are based on the assumption that the average spatially lagged provision of people goods is 20.12 Million Euro.

the results. Moreover, the point estimate show that positive and significant point estimate of other PIGS is mainly driven by a positive and significant effect of the provision of public streets.

Next we analyze the effect of the provision of public streets on *Transport Intensive Industries* (see specifications (5) to (8) of Table (3.4)). We do find evidence in favor of a negative effect of local business taxation in the taxing municipality and a positive effect of taxation in neighboring municipalities in all specifications. However, we do not find evidence in favor of a positive effect of street provision. The point estimates are positive but insignificant. Using the full set of PIGS categories we identify a positive and significant effect of economic promotion on *Non-Transport Intensive Industries*.[29]

Summarizing, we do find evidence in favor of a positive effect of people goods on *Family Intensive Industries* and competition effects between neighboring municipalities. Using *Transport Intensive Industries* we do not find evidence for significant effects of street provision. Thus, while considering subcategories of PIGS spending does not give significant effects on the number of firm foundations in every specification this may be due to three reasons. First, firms might not or are not able to collect information about specific assets and only value the total capital stock when choosing localities. Second, our proxies for the capital value of the assets might insufficiently capture its real value. Note that our calculation of the capital stock relies on expenditures. However, we are not able to separate municipalities with efficient fiscal policies from inefficient municipalities which might bias our proxies.[30] Lastly and most importantly, splitting PIGS spending in subcategories and weighting our instrument with pre-sample shares does significantly reduce the power of our instrument, and thus increases estimated standard errors. We can conclude that different industries do not equally benefit by municipalities spending for various PIGS categories.

[29] See specifications (6) and (8) in Table (3.10).

[30] Note that if our proxies for the assets are biased, we expect the bias to diminish with respect to the level of aggregation. Hence, we expect our proxy for the total capital stock to be a more efficient proxy.

VI. Conclusion

The aim of this paper was to determine the effect of public goods and service provision (PIGS) on firm foundation and location choices. We applied Poisson regressions implementing a control function approach to address concerns about the exogeneity of the PIGS capital stock and the local business tax rate. The results indicate that, first, PIGS spending has a positive and significant effect on the number of firm foundations in the PIGS providing municipality. Hence, municipalities can use PIGS spending as a policy instrument to attract mobile capital and increase foundation rates. Second, total PIGS spending of neighboring municipalities within 15km has a positive (although insignificant) effect on local firm foundations supporting the assumption of spillover effects between close jurisdictions. Additionally, we assess the effects of taxation. The results are in line with the literature and theoretical expectations. Increasing the local business tax rate decreases the number of local firm foundations. Furthermore, increasing local business tax rates in neighboring municipalities has a significant positive effect on local firm foundations, and thus supports the notion of competition effects with respect to local business tax rates.

Considering different PIGS categories yields mixed results. We do find evidence in favor of a positive effect of people goods (e.g. child- and youth care or public transportation) on industries that are strongly dependent on employees aged 35 to 49. On top, we identify dominating competition effects between neighboring municipalities with respect to the provision of people goods on firm foundations in *Family Intensive Industries*. Although we do not find evidence in favor of a positive effect of street provision for industries that are *Transportation Intensive*, the effect of the local business tax rate is negative and significant in all specifications.

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Appendix A: First Stage Results of the Control Function Framework

Table 3.5: First Stage Estimates

	Tax (1)	Stock (2)	(0 − 15km) Tax (3)	(0 − 15km) Stock (4)
Reference Tax Dummy	8.6476***	0.1377	1.8179***	-0.1767
	(0.7791)	(0.2669)	(0.3563)	(0.1558)
($0-15$km) Reference Tax Dummy	18.7990***	-2.7488***	22.9233***	-1.1876***
	(1.8893)	(0.6574)	(1.1752)	(0.4198)
Wind X Agriculture X Reform	-0.0014	0.0063***	-0.0004	-0.0006***
	(0.0013)	(0.0010)	(0.0007)	(0.0002)
Wind X Agriculture X Reform X Trend	-0.0002	0.0005**	-0.0003	0.0000
	(0.0004)	(0.0003)	(0.0003)	(0.0001)
($0-15$km) Wind X Agriculture X Reform	-0.0070***	-0.0024**	-0.0074***	0.0041***
	(0.0024)	(0.0012)	(0.0011)	(0.0005)
($0-15$km) Wind X Agriculture X Reform X Trend	-0.0016**	-0.0009**	-0.0012***	-0.0009***
	(0.0008)	(0.0004)	(0.0004)	(0.0003)
Population in 1000	-0.0844	1.3747**	0.1215	-0.2838*
	(0.2742)	(0.5655)	(0.1466)	(0.1631)
($0-15$km) Population in 1000	-0.0378	0.1722	0.1099**	0.8601***
	(0.1054)	(0.1495)	(0.0459)	(0.1972)
Unemployment Rate	-0.3220**	0.0611	0.0852	0.0047
	(0.1397)	(0.0878)	(0.0681)	(0.0354)
($0-15$km) Unemployment Rate	1.0120***	-0.1822	0.6512***	-0.1771***
	(0.2176)	(0.1274)	(0.1030)	(0.0604)
Share Low Skilled Workers	-0.1099	0.0202	-0.0514	-0.0416
	(0.1442)	(0.0669)	(0.0610)	(0.0521)
Share Medium Skilled Workers	0.0673	-0.1013**	0.1576***	-0.3213***
	(0.1177)	(0.0476)	(0.0479)	(0.0307)
Share High Skilled Workers	0.2347	0.7184***	0.3673***	0.5940***
	(0.2570)	(0.2191)	(0.1028)	(0.1317)
Doctors	-0.0317**	0.0359***	-0.0112*	-0.0083
	(0.0156)	(0.0130)	(0.0058)	(0.0059)
Students	0.0327	0.0203	0.0229*	0.0012
	(0.0305)	(0.0448)	(0.0122)	(0.0076)
Wind X Reform	0.1916	-0.7311***	-0.3134*	-0.0536
	(0.8357)	(0.1413)	(0.1818)	(0.0461)
Wind X Reform X Trend	0.0934	-0.1657***	0.0590	-0.0222
	(0.1746)	(0.0492)	(0.0693)	(0.0253)
($0-15$km) Wind X Reform	-0.2603	0.5807***	0.4007*	-0.2200***
	(0.7794)	(0.1538)	(0.2074)	(0.0599)
($0-15$km) Wind X Reform X Trend	0.2604	0.1715***	0.2396***	0.0213
	(0.1888)	(0.0555)	(0.0814)	(0.0340)
Observations	70653	70653	70653	70653
F-Statistic	96.33***	16.71***	668.37***	131.84***
Year Fixed Effects	✓	✓	✓	✓
State X Year Fixed Effects	✓	✓	✓	✓
Municipality Fixed Effects	✓	✓	✓	✓

$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. *Source:* Own data collection and calculations. Robust clustered standard errors in parentheses.

Appendix B: Robustness Checks and Alternative Spatial Weights

Appendix B.1: Robustness Checks

Table 3.6: Robustness of the Control Function Specification

	Total Stock		per Capita	Expenditures	Voluntary	Categories
Distance	20km	40km	15km			
	(1)	(2)	(3)	(4)	(5)	(6)
Local Business Tax	-0.0121**	-0.0095**	-0.0227**	-0.0088*	-0.0130***	-0.0137***
	(0.0050)	(0.0043)	(0.0090)	(0.0048)	(0.0048)	(0.0048)
$(0-d\text{km})$ Local Business Tax	0.0149**	0.0065	0.0269**	0.0172***	0.0192***	0.0176***
	(0.0061)	(0.0064)	(0.0118)	(0.0064)	(0.0065)	(0.0062)
Total Capital Stock	0.0223***	0.0154*				
	(0.0079)	(0.0086)				
$(0-d\text{km})$ Total Capital Stock	0.0154	-0.0396				
	(0.0276)	(0.0317)				
Total Capital Stock per Capita			0.0016			
			(0.0010)			
$(0-d\text{km})$ Total Capital Stock per Capita			-0.0019			
			(0.0016)			
Expenditures				0.0202***		
				(0.0061)		
$(0-d\text{km})$ Expenditures				0.0174		
				(0.0143)		
Voluntary Capital Stock					0.0220**	
					(0.0109)	
$(0-d\text{km})$ Voluntary Capital Stock					0.0149	
					(0.0248)	
People Goods						0.0007
						(0.0176)
$(0-d\text{km})$ People Goods						0.0042
						(0.0260)
Streets						0.0070
						(0.0144)
$(0-d\text{km})$ Streets						-0.0004
						(0.0225)
Economic Promotion						0.1157
						(0.0742)
$(0-d\text{km})$ Economic Promotion						0.0152
						(0.1659)
Other Stock					0.0417	-0.0399
					(0.0395)	(0.0578)
$(0-d\text{km})$ Other Stock					0.1075	0.1317
					(0.1186)	(0.1216)
N	70653	70653	70645	70645	70645	70645
Year Fixed Effects	✓	✓	✓	✓	✓	✓
Municipality Fixed Effects	✓	✓	✓	✓	✓	✓
State X Year Fixed Effects	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓
Bootstraped SE	✓	✓	✓	✓	✓	✓
# Bootstraps	100	100	100	100	100	100

*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$. *Source:* Own data collection and calculations. *Notes:* Bootstrapped and clustered standard errors in parentheses.

Appendix B.2: Alternative Spatial Weights

Table 3.7: Average Spatial Variables

	15km (1)	20km (2)	40km (3)
Local Business Tax	-0.0132***	-0.0110*	-0.0084**
	(0.0033)	(0.0061)	(0.0042)
$(0-d)$ Local Business Tax	0.0183***	0.0125*	0.0003
	(0.0047)	(0.0072)	(0.0076)
Total Capital Stock	0.0264***	0.0211***	0.0112
	(0.0087)	(0.0077)	(0.0081)
$(0-d)$ Total Capital Stock	0.0300	0.0061	-0.0509
	(0.0284)	(0.0308)	(0.0349)
Population in 1000	-0.0233	-0.0232	-0.0153
	(0.0272)	(0.0168)	(0.0157)
$(0-d)$ Population in 1000	-0.0351	-0.0151	0.0513
	(0.0282)	(0.0316)	(0.0371)
Unemployment Rate	0.0264***	0.0276***	0.0293***
	(0.0065)	(0.0082)	(0.0072)
$(0-d)$ Unemployment Rate	-0.0223*	-0.0251**	-0.0253
	(0.0120)	(0.0106)	(0.0168)
Share Low Skilled Workers	0.0013	0.0021	-0.0026
	(0.0074)	(0.0085)	(0.0086)
Share Medium Skilled Workers	0.0105	0.0022	-0.0137
	(0.0093)	(0.0156)	(0.0147)
Share High Skilled Workers	-0.0529*	-0.0257	-0.0054
	(0.0280)	(0.0233)	(0.0153)
Share Doctors	0.0011	0.0009	0.0020**
	(0.0008)	(0.0009)	(0.0010)
Share Students	0.0018	0.0018	0.0011
	(0.0014)	(0.0011)	(0.0010)
Wind x Reform	0.0040	-0.0037	0.0007
	(0.0266)	(0.0215)	(0.0166)
Wind x Reform x Trend	-0.0245***	-0.0199***	-0.0083**
	(0.0078)	(0.0063)	(0.0041)
$(0-d)$ Wind x Reform	-0.0087	-0.0025	-0.0223
	(0.0264)	(0.0303)	(0.0236)
$(0-d)$ Wind x Reform x Trend	0.0356***	0.0313***	0.0176***
	(0.0095)	(0.0078)	(0.0057)
Residual Local Business Tax	0.0125***	0.0102*	0.0077*
	(0.0034)	(0.0062)	(0.0042)
Residual Total Capital Stock	-0.0255***	-0.0201***	-0.0100
	(0.0087)	(0.0077)	(0.0081)
Residual $(0-d\text{km})$ Local Business Tax	-0.0190***	-0.0136**	-0.0037
	(0.0045)	(0.0069)	(0.0069)
Residual $(0-d\text{km})$ Total Capital Stock	-0.0311	-0.0076	0.0498
	(0.0280)	(0.0311)	(0.0346)
N	70645	70645	70645
Year Fixed Effects	✓	✓	✓
Municipality Fixed Effects	✓	✓	✓
State X Year Fixed Effects	✓	✓	✓
Bootstraped SE	✓	✓	✓
# Bootstraps	100	100	100

*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$. *Source:* Own data collection and calculations.
Notes: Bootstrapped and clustered standard errors in parentheses.

Table 3.8: Inverse Distance Squared Weighted Spatial Variables

	15km (1)	20km (2)	40km (3)
Local Business Tax	-0.0137**	-0.0127**	-0.0114**
	(0.0058)	(0.0053)	(0.0050)
$(0 - d\text{km})$ Local Business Tax	0.0181***	0.0159**	0.0130*
	(0.0069)	(0.0063)	(0.0070)
Total Capital Stock	0.0258***	0.0236***	0.0221***
	(0.0090)	(0.0083)	(0.0082)
$(0 - d\text{km})$ Total Capital Stock	0.0272	0.0198	-0.0130
	(0.0288)	(0.0276)	(0.0327)
Population in 1000	-0.0269	-0.0255	-0.0284
	(0.0247)	(0.0232)	(0.0223)
Unemployment Rate	0.0239***	0.0255***	0.0267***
	(0.0091)	(0.0085)	(0.0080)
Share Low Skilled Workers	0.0029	0.0024	0.0009
	(0.0078)	(0.0080)	(0.0079)
Share Medium Skilled Workers	0.0072	0.0053	-0.0039
	(0.0101)	(0.0108)	(0.0119)
Share High Skilled Workers	-0.0427**	-0.0358**	-0.0201
	(0.0192)	(0.0179)	(0.0184)
Doctors	0.0007	0.0007	0.0009
	(0.0010)	(0.0010)	(0.0009)
Students	0.0013	0.0014	0.0013
	(0.0014)	(0.0013)	(0.0012)
$(0 - d\text{km})$ Population in 1000	-0.0261	-0.0230	0.0020
	(0.0223)	(0.0236)	(0.0307)
$(0 - d\text{km})$ Unemployment Rate	-0.0160	-0.0194	-0.0258*
	(0.0122)	(0.0124)	(0.0141)
Wind x Reform	0.0091	-0.0028	-0.0009
	(0.0394)	(0.0387)	(0.0323)
Wind x Reform x Trend	-0.0358***	-0.0325***	-0.0246***
	(0.0100)	(0.0095)	(0.0081)
$(0 - d\text{km})$ Wind x Reform	-0.0180	-0.0037	-0.0083
	(0.0418)	(0.0432)	(0.0400)
$(0 - d\text{km})$ Wind x Reform x Trend	0.0469***	0.0449***	0.0371***
	(0.0114)	(0.0113)	(0.0102)
Residual Local Business Tax	0.0130**	0.0120**	0.0107**
	(0.0058)	(0.0054)	(0.0051)
Residual Total Capital Stock	-0.0248***	-0.0227***	-0.0211**
	(0.0090)	(0.0083)	(0.0083)
Residual $(0 - d\text{km})$ Local Business Tax	-0.0186***	-0.0165**	-0.0145**
	(0.0070)	(0.0065)	(0.0073)
Residual $(0 - d\text{km})$ Total Capital Stock	-0.0277	-0.0207	0.0111
	(0.0285)	(0.0277)	(0.0329)
N	70653	70653	70653
Year Fixed Effects	✓	✓	✓
Municipality Fixed Effects	✓	✓	✓
State X Year Fixed Effects	✓	✓	✓
Bootstraped SE	✓	✓	✓
# Bootstraps	100	100	100

$^*p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. *Source:* Own data collection and calculations.
Notes: Bootstrapped and clustered standard errors in parentheses.

Table 3.9: Population Weighted Spatial Variables

	15km (1)	20km (2)	40km (3)
Local Business Tax	-0.0107***	-0.0094**	-0.0076**
	(0.0037)	(0.0039)	(0.0034)
$(0 - d\text{km})$ Local Business Tax	0.0051	0.0030	-0.0023
	(0.0039)	(0.0039)	(0.0042)
Total Capital Stock	0.0060	0.0096	0.0140
	(0.0087)	(0.0085)	(0.0088)
$(0 - d\text{km})$ Total Capital Stock	-0.0021	-0.0013*	-0.0008*
	(0.0013)	(0.0007)	(0.0005)
Population in 1000	-0.0049	-0.0074	-0.0117
	(0.0161)	(0.0169)	(0.0189)
$(0 - d\text{km})$ Population in 1000	0.0091	0.0058	0.0051*
	(0.0063)	(0.0039)	(0.0029)
Unemployment Rate	0.0202***	0.0199***	0.0249***
	(0.0077)	(0.0069)	(0.0064)
$(0 - d\text{km})$ Unemployment Rate	0.0003	0.0035	-0.0115
	(0.0122)	(0.0115)	(0.0143)
Share Low Skilled Workers	0.0053	0.0051	0.0040
	(0.0091)	(0.0086)	(0.0081)
Share Medium Skilled Workers	-0.0050	-0.0050	-0.0027
	(0.0061)	(0.0068)	(0.0076)
Share High Skilled Workers	0.0112	0.0057	-0.0090
	(0.0212)	(0.0176)	(0.0154)
Doctors	0.0007	0.0008	0.0014
	(0.0010)	(0.0009)	(0.0009)
Students	0.0018**	0.0014	0.0006
	(0.0009)	(0.0009)	(0.0011)
Wind x Reform	-0.0179	0.0114	0.0127
	(0.0333)	(0.0309)	(0.0217)
Wind x Reform x Trend	-0.0230***	-0.0219***	-0.0090*
	(0.0082)	(0.0073)	(0.0051)
$(0 - d\text{km})$ Wind x Reform	0.0071	-0.0332	-0.0439
	(0.0350)	(0.0342)	(0.0289)
$(0 - d\text{km})$ Wind x Reform x Trend	0.0318***	0.0334***	0.0249***
	(0.0097)	(0.0092)	(0.0082)
Residual Local Business Tax	0.0100***	0.0087**	0.0070**
	(0.0037)	(0.0039)	(0.0034)
Residual Total Capital Stock	-0.0050	-0.0086	-0.0128
	(0.0087)	(0.0085)	(0.0088)
Residual $(0 - d\text{km})$ Local Business Tax	-0.0066*	-0.0048	-0.0035
	(0.0038)	(0.0039)	(0.0043)
Residual $(0 - d\text{km})$ Total Capital Stock	0.0020	0.0012	0.0007
	(0.0013)	(0.0007)	(0.0005)
N	70653	70653	70653
Year Fixed Effects	✓	✓	✓
Municipality Fixed Effects	✓	✓	✓
State X Year Fixed Effects	✓	✓	✓
Bootstraped SE	✓	✓	✓
# Bootstraps	100	100	100

*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$. *Source:* Own data collection and calculations.
Notes: Bootstrapped and clustered standard errors in parentheses.

Appendix C: The Effects of PIGS on Intensive Industries

Table 3.10: The Effects of PIGS on Family and Transport Intensive Industries

	Median		Pctl(75)		Median		Pctl(75)	
	Family Intensive Industries				Transport Intensive Industries			
	Yes	No	Yes	No	Yes	No	Yes	No
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Local Business Tax	-0.0164*	-0.0134**	-0.0262	-0.0132**	-0.0150***	-0.0119	-0.0169***	-0.0122***
	(0.0096)	(0.0054)	(0.0244)	(0.0054)	(0.0038)	(0.0073)	(0.0065)	(0.0046)
($0-15$km) Local Business Tax	0.0156	0.0179***	0.0489	0.0172**	0.0186***	0.0161**	0.0209**	0.0163***
	(0.0136)	(0.0068)	(0.0306)	(0.0073)	(0.0062)	(0.0079)	(0.0083)	(0.0059)
People Goods	0.0611**	-0.0071	0.1512**	-0.0044	0.0052	-0.0069	0.0185	-0.0087
	(0.0288)	(0.0169)	(0.0604)	(0.0195)	(0.0133)	(0.0165)	(0.0193)	(0.0185)
($0-15$km) People Goods	-0.0487	0.0109	-0.1785**	0.0100	-0.0037	0.0088	-0.0145	0.0116
	(0.0447)	(0.0273)	(0.0762)	(0.0303)	(0.0234)	(0.0284)	(0.0276)	(0.0287)
Streets	0.0481**	0.0014	0.1140**	0.0035	0.0102	0.0019	0.0181	0.0012
	(0.0236)	(0.0135)	(0.0507)	(0.0158)	(0.0106)	(0.0137)	(0.0157)	(0.0142)
($0-15$km) Streets	-0.0550	0.0063	-0.1484**	0.0052	-0.0173	0.0176	-0.0256	0.0113
	(0.0424)	(0.0237)	(0.0739)	(0.0273)	(0.0208)	(0.0263)	(0.0242)	(0.0228)
Economic Promotion	-0.1330	0.1435	-0.4632	0.1376	0.0837	0.1630*	0.0019	0.1756*
	(0.1380)	(0.0882)	(0.2934)	(0.0899)	(0.0703)	(0.0888)	(0.0839)	(0.1014)
($0-15$km) Economic Promotion	0.1334	0.0072	1.1582*	-0.0042	-0.0197	0.0922	0.0317	0.0243
	(0.3349)	(0.1722)	(0.6538)	(0.1730)	(0.1556)	(0.2002)	(0.1935)	(0.1929)
Other Stock	0.1165	-0.0581	0.2859	-0.0524	-0.0242	-0.0638	0.0187	-0.0707
	(0.0997)	(0.0665)	(0.2350)	(0.0620)	(0.0536)	(0.0696)	(0.0563)	(0.0748)
($0-15$km) Other Stock	-0.0631	0.1538	-0.0561	0.1419	0.0912	0.1673	0.0382	0.1791
	(0.1780)	(0.1114)	(0.3617)	(0.1175)	(0.1175)	(0.1133)	(0.1350)	(0.1137)
Population in 1000	-0.1027	0.0478	-0.1477	0.0394	0.0089	0.0624	-0.0187	0.0579
	(0.0971)	(0.0525)	(0.1821)	(0.0630)	(0.0446)	(0.0507)	(0.0603)	(0.0575)
($0-15$km) Population in 1000	0.0377	-0.0239	0.1546*	-0.0226	-0.0134	-0.0169	-0.0003	-0.0241
	(0.0435)	(0.0288)	(0.0836)	(0.0334)	(0.0224)	(0.0290)	(0.0221)	(0.0279)
Unemployment Rate	-0.0006	0.0295***	-0.0617	0.0288***	0.0236***	0.0309**	0.0263**	0.0271***
	(0.0148)	(0.0102)	(0.0506)	(0.0094)	(0.0087)	(0.0119)	(0.0119)	(0.0089)
($0-15$km) Unemployment Rate	-0.0025	-0.0178	-0.0814	-0.0156	-0.0096	-0.0238	-0.0163	-0.0164
	(0.0286)	(0.0166)	(0.0648)	(0.0136)	(0.0132)	(0.0193)	(0.0172)	(0.0142)
Share Low Skilled Workers	-0.0015	0.0101	-0.1034*	0.0109	-0.0005	0.0182	-0.0069	0.0172
	(0.0219)	(0.0084)	(0.0620)	(0.0103)	(0.0116)	(0.0132)	(0.0123)	(0.0111)
Share Medium Skilled Workers	-0.0282	0.0058	-0.0999**	0.0049	-0.0061	0.0110	-0.0125	0.0101
	(0.0188)	(0.0100)	(0.0432)	(0.0112)	(0.0088)	(0.0110)	(0.0112)	(0.0098)
Share High Skilled Workers	-0.0342	-0.0345*	0.0692	-0.0374	-0.0189	-0.0550**	-0.0134	-0.0455**
	(0.0440)	(0.0203)	(0.1077)	(0.0230)	(0.0207)	(0.0240)	(0.0225)	(0.0211)
Doctors	-0.0027	0.0016	-0.0139**	0.0015	0.0010	0.0014	0.0009	0.0014
	(0.0021)	(0.0011)	(0.0063)	(0.0012)	(0.0010)	(0.0014)	(0.0012)	(0.0013)
Students	0.0035	-0.0011	0.0142	-0.0011	0.0006	-0.0026	0.0019	-0.0022
	(0.0052)	(0.0024)	(0.0166)	(0.0023)	(0.0020)	(0.0029)	(0.0025)	(0.0026)
N	54525	70254	34143	70522	68838	66344	63563	69517
Instrument Controls	✓	✓	✓	✓	✓	✓	✓	✓
Control Function Residuals	✓	✓	✓	✓	✓	✓	✓	✓
Year Fixed Effects	✓	✓	✓	✓	✓	✓	✓	✓
Municipality Fixed Effects	✓	✓	✓	✓	✓	✓	✓	✓
State X Year Fixed Effects	✓	✓	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓	✓	✓
Bootstraped SE	✓	✓	✓	✓	✓	✓	✓	✓
# Bootstraps	100	100	100	100	100	100	100	100

*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$. *Source:* Own data collection and calculations. *Notes:* Other Stock is the difference between Total Capital Stock and the sum of voluntary spending in each specification. Bootstrapped and clustered standard errors in parentheses.

Appendix D: Complete Baseline Estimation Table

Table 3.11: Complete Baseline Poisson Regressions

	Poisson (1)	CF (2)	Poisson (3)	CF (4)	Poisson (5)	CF (6)	CF (7)
Local Business Tax	-0.0010**	-0.0083***			-0.0009*	-0.0084***	-0.0137**
	(0.0005)	(0.0019)			(0.0005)	(0.0021)	(0.0055)
(0-15) Local Business Tax							0.0188***
							(0.0065)
Total Capital Stock (in 1M Euro)			0.0014***	0.0199**	0.0013**	0.0120	0.0257***
			(0.0005)	(0.0086)	(0.0005)	(0.0081)	(0.0086)
(0-15) Total Capital Stock (in 1M Euro)							0.0327
							(0.0273)
Population in 1000	0.0068	0.0051	0.0062	-0.0208	0.0061	-0.0102	-0.0234
	(0.0054)	(0.0063)	(0.0055)	(0.0205)	(0.0055)	(0.0173)	(0.0247)
(0-15) Population in 1000							-0.0351
							(0.0242)
Unemployment Rate	0.0266***	0.0277***	0.0277***	0.0275***	0.0276***	0.0282***	0.0252***
	(0.0063)	(0.0055)	(0.0064)	(0.0052)	(0.0064)	(0.0052)	(0.0089)
(0-15) Unemployment Rate							-0.0198
							(0.0125)
Share Low Skilled Workers	0.0081	0.0077	0.0076	0.0059	0.0071	0.0051	0.0020
	(0.0077)	(0.0065)	(0.0076)	(0.0068)	(0.0076)	(0.0069)	(0.0078)
Share Medium Skilled Workers	0.0037	0.0050	0.0037	0.0050	0.0033	0.0046	0.0097
	(0.0059)	(0.0049)	(0.0060)	(0.0053)	(0.0060)	(0.0052)	(0.0114)
Share High Skilled Workers	-0.0038	-0.0013	-0.0090	-0.0221	-0.0102	-0.0139	-0.0505**
	(0.0125)	(0.0115)	(0.0125)	(0.0150)	(0.0124)	(0.0146)	(0.0226)
Share Doctors	0.0027***	0.0024***	0.0024***	0.0015**	0.0023***	0.0015***	0.0009
	(0.0008)	(0.0005)	(0.0007)	(0.0006)	(0.0007)	(0.0005)	(0.0011)
Share Students	0.0020**	0.0022**	0.0021***	0.0017	0.0021***	0.0021**	0.0015
	(0.0008)	(0.0010)	(0.0007)	(0.0010)	(0.0007)	(0.0009)	(0.0014)
Wind X Reform				-0.0066		-0.0110	0.0063
				(0.0133)		(0.0129)	(0.0362)
(0-15) Wind X Reform							-0.0126
							(0.0388)
Wind X Reform X Trend				-0.0001		0.0027	-0.0302***
				(0.0029)		(0.0027)	(0.0093)
(0-15) Wind X Reform X Trend							0.0420***
							(0.0105)
Residual Local Business Tax		0.0074***		-0.0186**		0.0077***	0.0130**
		(0.0020)		(0.0085)		(0.0022)	(0.0055)
Residual Total Capital Stock						-0.0108	-0.0248***
						(0.0081)	(0.0086)
Residual (0-15) Local Business Tax							-0.0194***
							(0.0066)
Residual (0-15) Total Capital Stock							-0.0337
							(0.0272)
N	70653	70653	70653	70653	70653	70653	70653
log likelihood	-128812.14		-128780.50		-128761.58		
chi.squared	1913.99***		1984.39***		1979.35***		
Year Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Municipality Fixed Effects	✓	✓	✓	✓	✓	✓	✓
State X Year Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Bootstraped SE		✓		✓		✓	✓
# Bootstraps		100		100		100	100

*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$. *Source:* Own data collection and calculations. Bootstrapped and clustered standard errors in parentheses.

Chapter 4

Firm Foundation and Localization Economies - The Sensitivity to Taxation and Public Good and Service Provision

Christian Wittrock*

Abstract

This paper investigates the influence of tax rates and public goods and services on the number of firm foundations in West German municipalities in the presence of localization economies. Brülhart *et al.* (2012) use Swiss data to show that localization economies can mitigate the negative effects of taxation on firm foundation rates. Firms are more willing to accept higher tax rates if localizing patterns exist within their industry that generate beneficial spillover effects. This potential agglomeration rents can be taxed by municipalities (see Koh *et al.* 2013) and localities can use additional revenues for public spending. This work exploits information on the localization of German industries on a 2 digit level based on work by Koh and Riedel (2014). It is combined with detailed data on firm foundation, the local business tax rate and public good and service provision in West German municipalities to analyze the sensitivity of firm foundations to changes in the local tax rate as well as public good and service provision with respect to localization economies. Similar to Brülhart *et al.* (2012) the results for Germany imply that localization can diminish the negative effects of taxation. On top, the results show that the positive effect of public goods and services (namely economic promotion and municipalities total capital stock) is mitigated by localization economies.

JEL Classification: R12, R3, H25, H41
Keywords: Firm location; Agglomeration; Taxation; Regional Policy; Public Goods

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I. Introduction

Economic activity is not equally distributed across space. Since Marshall (1890) economist have raised the question: Where do firms locate? Most notably, starting with Krugman's (1991) work on "new economic geography" many contributions to the literature discussed the effects of agglomeration economies. Agglomeration creates incentives for mobile investment to seek proximity to benefit from spillovers. These spillovers can be classified into two main types (1) localization economies (see Marshall 1890, Arrow 1962, Romer 1986) and (2) urbanization economies (Jacobs 1969). Localization economies increase productivity of firms with increasing size of an industry in a geographical location, e.g. by knowledge spillovers of firms within close distance that are spatially concentrated (see Audretsch and Feldman 1996, for R&D spillovers). Marshall (1890) and Krugman (1991) argue that these spillovers might be geographically bounded with the costs of transmitting information increasing with distance. Urbanization economies benefits firms locating in a region and increase with the size of the region, e.g. by better access to a larger labor force (see Rosenthal and Strange 2004, for a discussion). The first is beneficial for firms in the same industry and the latter is common to all firms (Maurel and Sédillot 1999). Depending on the dominance of a spillover either specialized areas or industrially diversified areas emerge (Jacobs 1969). More importantly, if firms benefit from locating close to each other this can affect the sensitivity of firms to location characteristics (see Brülhart *et al.* 2012) and create possibilities for municipalities to tax agglomeration rents (see Koh *et al.* 2013). The standard theory of tax competition states that increasing firm mobility results in a race to the bottom of corporate taxes (see Wilson 1999, for a review). Simultaneously, this result remains and open discussion in the empirical literature using localities in Germany (see e.g. Buettner 2003, Baskaran 2014). A number of theoretical contributions discuss the interacting effects of agglomeration and the local tax setting (see e.g Kind *et al.* 2000, Ludema and Wooton 2000, Andersson and Forslid 2003, Baldwin and Krugman 2004, Borck and Pflüger 2006, Baldwin and Okubo 2009). This paper aims to analyze the sensitivity of firms location decisions with respect to localization economies. More specific, following a recent contribution by Brülhart *et al.* (2012) one aim of this paper is to assess the sensitivity of firm foundation rates to changes of the local business tax if firms benefit from localization. On top, this work will contribute adding an analysis of the localization sensitivity of firm foundations to public goods and services (PIGS). Devereux *et al.* (2007) show for a model of plant location in Great-Britain that agglomeration externalities have an effect on the responsiveness of firms to fiscal incentives. In detail, they find that fiscal incentives have a greater impact in regions with a larger stock of existing plants. They do not explicitly model the effect of localization and fiscal incentives on firm births. Note that the literature on these interaction effects is scarce. This paper will contribute exploiting rich data on firm foundations, PIGS provision and local business taxation in West German municipalities from 1998 to 2006. First, the data allows to replicate the results of Brülhart *et al.* (2012) for German data and to review their results. Second, the data allows to explicitly address the interaction effects of localization and PIGS provision on the number of firm foundations.

Following Brülhart *et al.* (2012) and Guimarães *et al.* (2003) the decision process of firms location choice can be modeled and estimated using a Poisson regression. Hence, using detailed data on firm foundations, taxation and PIGS provision in a Poisson model I can explicitly address the question to what extent local business taxes and PIGS provision affect firm foundation rates. Moreover, it allows to analyze the sensitivity of both effects to localization economies. I identify a negative effect of a 1% increase of the mean local business tax on the expected number of firm foundations in non-localized industries of 4.4%. On top, the sensitivity of firm foundations to changes in the local business tax decreases significantly with increasing localization economies. Thus, a 1% increase of the average local business tax decreases the expected number of firm foundations in top-localized industries by 1.34%. In contrast, a 1% increase of mean PIGS provision (represented by the capital stock for economic promotion) increases the expected number of firm foundations in non-localized industries by 0.13%. Again, this effects decreases significantly with increasing localization. A 1% increase of the average economic promotion capital stock increases the expected number of firm foundations in top-localized industries by 0.08%. Hence, the negative effects of taxation and the positive effects of PIGS provision are supplanted by localization economies and thus firm foundations in strongly localized industries are less sensitive to changes of local taxation and PIGS provision.

The remainder of this article is structured as follows. Section II presents the institutional background and data necessary to understand the research approach and the results. The measure for localization used in this article is explained in section III. The empirical model, empirical obstacles, results and some remarks on robustness are discussed in sections IV to VI. Section VII concludes.

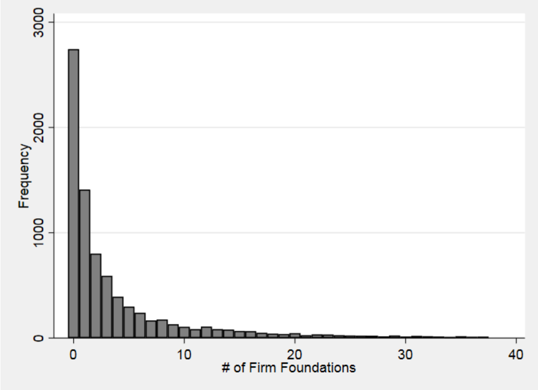
II. Institutional Background and Data

The analysis to come will exploit rich data on municipalities in West Germany which are the lowest institutional level in Germany. Municipalities have self elected governments that can autonomously set policies to attract mobile capital. The latter will be represented by the number of firm foundations based on public data called '*Gewerbeanzeigenstatistik*'. Firms are mandatory to register if they set up a new firm or branch in Germany.[1] The data is available for the years 1998 to 2006. Figure (4.1) depicts the number of new firm foundations in 2006 (in my sample). A mass of municipalities experience zero or only one firm foundation per year. This is based on the fact that many municipalities are small entities with a small probability of a firm locating there. This probability plays an important factor understanding the impact of changes in municipalities policies.

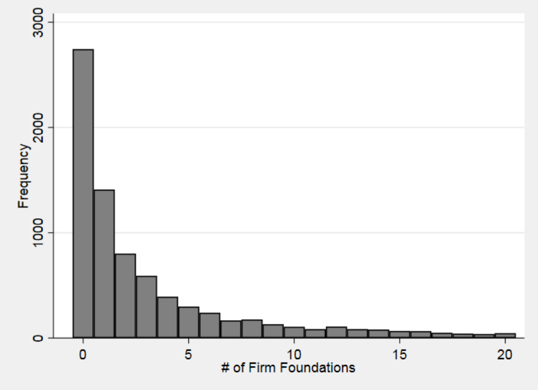
Municipalities are mainly funded by three sources. First, some revenues, e.g. the personal income tax, are collected on the federal state or country level and distributed among governmental levels. Municipalities receive 15% of the overall income tax

[1]Note that the *Gewerbeanzeigenstatistik* also includes self-employed firms. Our sample of firm foundations does include all registrations of corporations, partnerships and self-employed firms with at least 1 employee.

Figure 4.1: Histograms of the Number of Firm Foundations in Germany Municipalities in 2006.



(a) Number of Firm Foundations (Cut at the 95% Quantile).



(b) Number of Firm Foundations (Maximum 20).

revenues. Second, municipalities set the local property tax and local business tax multipliers to generate own sources of revenues.[2] Third, other sources of revenues are generated via grants by the federal states or the German government.[3] Revenues are used for (1) mandatory and (2) voluntary public expenditures. Mandatory expenditures (e.g. social security) is administered by the local government while laws regarding these expenditures are made on the federal or state level. Municipalities are governed by local councils and majors who can decide about the level of voluntary expenditures e.g. theaters, museums, public parks, local streets, economic promotion and public investment. The local population and most importantly firms benefit from local public goods provided by the municipality.

Data for public expenditures is based on detailed accounting information for municipalities called '*Jahresrechnungsstatistik*' available for the years 1992 to 2006. This data contains information about the amount and target of public expenditures. Municipalities do not invest in public goods and services (PIGS) regularly over the years and expenditures show significant variance over time. Moreover, expenditures do not necessarily have a one-time impact and take effect over several years. To capture these effects I calculate capital stock values using yearly expenditures and official information about the operating lives of public investment using the perpetual in-

[2]Note that since 2004 the local business tax multiplier is bound from below by 200.
[3]Additionally, German municipalities set local taxes or collect fees for various services to generate revenues.

ventory method.

In detail, the capital stock of PIGS (henceforth called C) is calculated based on disaggregated accounting data of German municipalities between 1992 and 2006. The initial capital stock of a municipality is assumed to be equal to

$$K_0 = \frac{\overline{E}}{g_{gdp} + \frac{1}{T}} \tag{4.1}$$

with $\overline{E}$ the average expenditures for investment in and construction of public goods, g_{gdp} the GDP growth rate and T for the average publicly available operating life. Note that I will assume a GDP growth rate of 2% and linear depreciation of the capital stock. The capital stock C in municipality i at time t is given by

$$C_{i,t} = \sum_{k=0}^{T} E_{i,t-k}\left(1 - \frac{k}{T}\right) + AE_{i,t} \tag{4.2}$$

with $E_{i,t}$ investment and construction expenditures and $AE_{i,t}$ administration expenditures. Note that I assume that administration expenditures depreciate within one year. Furthermore, expenditures in 1992 (the starting year of the data) are equal to the capital expenditures plus the initial capital stock K_0. Hence, expenditures before 1992 are assumed to be equal to 0.

Following Devereux *et al.* (2007) I'm mainly interested in the effects of public expenditures for economic promotion (represented by the capital stock of economic promotion) on the number of firm foundations. I expect economic promotion to have the greatest impact on firm births as this public expenditures are directly targeted towards firms. The literature on the effects of PIGS provision on firms uses a variety of proxies (see e.g. Fisher 1997, Sturm *et al.* 1998, Romp and De Haan 2007). Hence, to control for the robustness of the results I additionally estimate the effect of the total capital stock on firm foundations. The total capital stock is the sum of voluntary PIGS.[4] Additionally, to control for the validity of the capital stock proxy

[4]Voluntary PIGS comprise of expenditures for (1) public security, (2) schools, (3) culture and public

I moreover estimate the effect of overall current (voluntary) public expenditures on firm foundations. Both robustness checks do not change the general implications of the results.

Table 4.1: Descriptive Statistics for 2006

	Mean	Std. Dev.	Pctl(25)	Pctl(75)
# of Firm Foundations (Full Sample)	7.86	24.49	0.00	6.00
# of Firm Foundations (Log Sample)	11.69	29.03	2.00	10.00
Population in 1000	6.49	16.55	0.72	5.74
Unemployment Rate in %	5.34	1.82	4.00	6.40
Share of Low Skilled Workers in %	17.54	2.95	15.20	19.70
Share of Medium Skilled Workers in %	63.33	3.73	60.60	65.90
Share of High Skilled Workers in %	5.58	2.28	4.20	6.10
Students per 1,000 Inhabitants	5.71	14.56	1.00	3.20
Doctors per 100,000 Inhabitants	131.71	22.57	121.40	138.40
Local Business Tax Multiplier in Points	339.25	31.17	320.00	352.00
Economic Promotion in 1 Million Euro	1.41	5.97	0.06	0.78
Total Stock in 1 Million Euro	29.43	67.44	3.18	29.00

Source: Own data collection and calculations. *Notes:* The table depicts the sum of firm foundations over all industries in 2006. The sample covers 8418 municipalities in the full sample and 5612 municipalities in the log-sample.

The data is augmented by socio-economic control variables such as population, the share of low, medium or high qualified employees as well as the tax multiplier of the local business tax based on the *Statistik Lokal* or *Inkar* databases. Overall, the sample comprises about 8,400 West-German municipalities for the years 1998 to 2006 and 41 industry classes.[5] Descriptive statistics for the year 2006 are provided in Table (4.1). The average municipality has approximately 7,500 inhabitants and 8 new firm foundations (in 2006). The average local business tax multiplier is 339 points and the average total capital stock is 30 Million Euro. Approximately 5% is due to economic promotion. Note that the variation in the total capital stock and capital stock of economic promotion is high among municipalities.[6]

education, (4) child- and youth care, (5) health, sport and recreation, (6) public transportation and parking facilities, (7) public streets, (8) economic promotion, (9) public construction and housing.

[5]Data for East Germany is available. I concentrate on West-Germany because the sample period is to close to reunification and economic conditions differ substantially between West- and East Germany.

[6]To exclude outliers I drop observations with more than 300,000 inhabitants as well as the federal states Bremen and Hamburg.

III. Localization Index

Localization will be measured using the agglomeration index for Germany proposed by Koh and Riedel (2014). The index (henceforth called LOC) is calculated using the method proposed by Duranton and Overman (2005). Based on the Duranton and Overman (2005) framework an industry is defined as being localized or dispersed if the distribution of bilateral distances within an industry significantly deviates from a random distribution of distances. By using a continues scale to determine agglomeration the LOC index avoids potential problems of other indexes e.g. the Gini Index or the Ellison and Glaeser (EG) index (for the later see Ellison and Glaeser 1997). In contrast to the EG index the LOC index does not assume ex ante allocation of firms. Following Duranton and Overman (2005), EG *transforms dots on a map into units in boxes* and deletes large amounts of information while creating aggregation problems. Among these problems is the restriction to one spatial scale. While this limits comparability of the agglomeration index between different scales and hence differing institutional settings (e.g. countries), scales are normally defined based on administrative and not economic relevance. Furthermore, the EG index creates a downward bias if agglomeration crosses administrative boundaries. Additionally, as noted by Ellison and Glaeser (1997) agglomeration indexes have to control for industrial concentration. Because the number of firms is not arbitrary large, a random location process cannot generate regular location patterns. The calculation of the LOC index can be separated into four steps (see Koh and Riedel 2014, for a detailed description).

Step 1: Calculation of the kernel density estimate

Information on the location of companies is used to calculate bilateral euclidean distances.[7] Distances are then used to calculate the density of bilateral distances

[7]Note that due to confidentiality issues of the data the location of companies within a municipality are assumed to be equal to the centroid of a municipality. Hence, distances of firms within the same municipality are zero. Koh and Riedel (2014) do not expect the calculated LOC index to be systematically biased. First, the measurement error does occur when calculating distances as well as counterfactuals. Secondly, the assumption does add unsystematic noise to the LOC index as distances within a municipality are underestimated and distances between firms of different

$\hat{K}_m(d)$ at any point (distance) d using

$$\hat{K}_m(d) = \frac{1}{n(n-1)h} \sum_{i=1}^{n-1} \sum_{j=i+1}^{n} f\left(\frac{d - d_{i,j}}{h}\right) \tag{4.3}$$

with n the number of firms in the industry and f the Gaussian kernel function with bandwidth (smoothing parameter) h.

Step 2: Constructing counterfactuals

A counterfactual kernel density estimate for each industry m is calculated to be compared with the estimate of equation (4.3) to identify significance deviation from randomness. Koh and Riedel (2014) use the population of all plants located in Germany and calculate the density estimate given by equation (4.3) with 1000 draws to generate 1000 counterfactuals for every industry m.

Step 3: Global confidence bands

For each distance d a $\hat{K}^s_{\tilde{m}}(d)$ is picked such that 95% of all randomly generated distance density functions lie above or below this band generating an upper $\overline{\hat{K}_{\tilde{m}}(d)}$ and lower $\underline{\hat{K}_{\tilde{m}}(d)}$ bound of kernel density estimates.

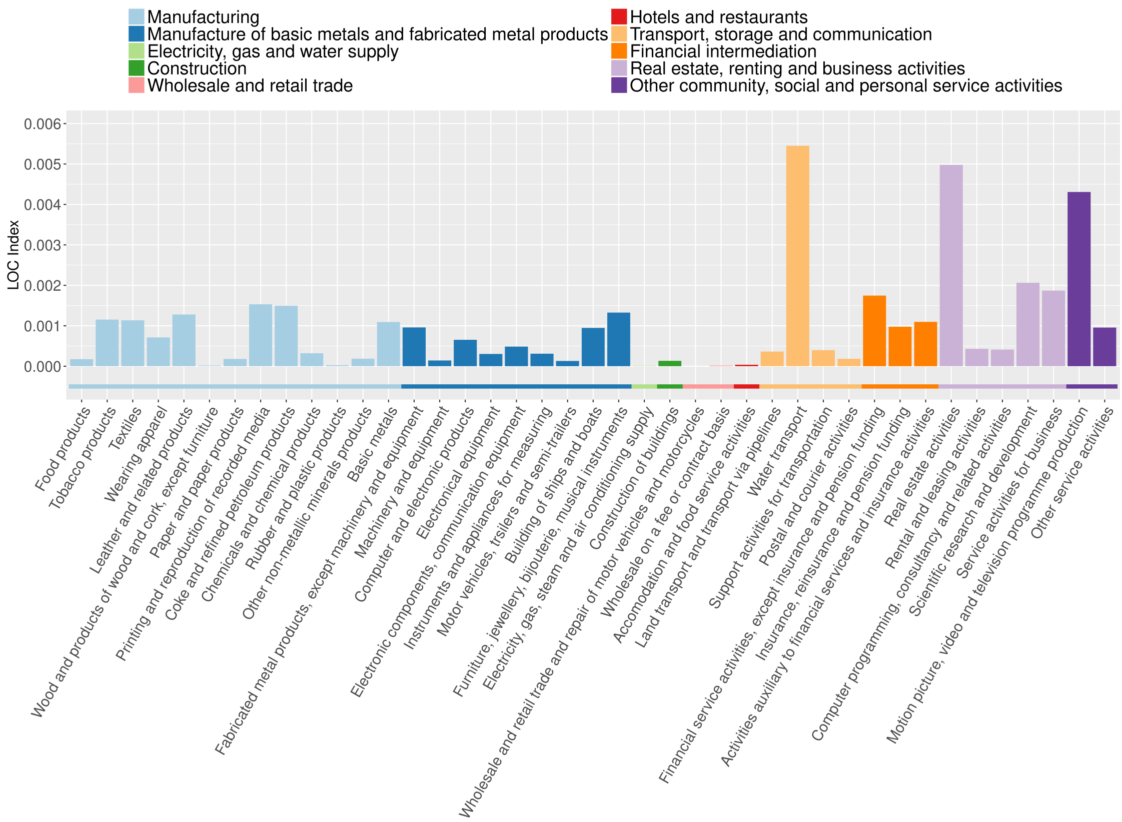
Step 4: Identification of localized industries

An industry is assumed to be localized if $\hat{K}_m(d) > \overline{\hat{K}_m(d)}$ or dispersed if $\hat{K}_m(d) < \underline{\hat{K}_m(d)}$ for at least one distance d. The localization index is defined as

$$\Gamma_m(d) \equiv \max\left(\hat{K}_m(d) - \overline{\hat{K}_m(d)}, 0\right) \tag{4.4}$$

municipalities are under- or overestimated.

Figure 4.2: Weighted LOC Index for Two-Digit Industries.



A larger index indicates stronger localization of industry m. As I'm mostly interested in the effect of taxation and economic promotion on firm foundation rates within a municipality the following analysis will use the localization index with distance $d = 0$. The localization index calculated by Koh and Riedel (2014) is based on data for the year 1999 while the panel used for estimating firm foundation rates ranges from 1998 to 2006. Hence, (although unlikely) the results do not capture variation in the localization due to significant changes in the number of firm foundation within a municipality. Dumais *et al.* (2002) report that geographical concentration is stable despite industry mobility. Therefore, I assume that the localization index is stable over the sample period.[8] Furthermore, the localization index is calculated using 4 digit industry classes. To calculate a localization index on a 2 digit industry level I calculate the weighted average of the 4-digit localization index weighted with the number of firms in every industry.[9] Figure (4.2) depicts the localization index used

[8]Moreover, to exclude significant variation in localization between the year 1998 and 1999 I repeated the estimations on the subsample from 1999 onwards. The results are basically unaffected.
[9]The number of firms in every industry is based on information of the DAFNE data set provided

for the main part of the analysis. Table (4.2) lists the 5 most and least localized industries.

Table 4.2: Most and Least Localized Industries and Weighted LOC Index for Two-Digit Industries.

Industry	Weighted LOC Index
Wholesale and retail trade and repair of motor vehicles and motorcycles	0.00000
Electricity, gas, steam and air conditioning supply	0.00001
Wood and products of wood and cork, except furniture	0.00002
Wholesale on a fee or contract basis	0.00002
Rubber and plastic products	0.00003
Service activities for business	0.00187
Scientific research and development	0.00206
Motion picture, video and television programme production	0.00431
Real estate activities	0.00498
Water transport	0.00545

Source: Own data collection and calculations.

As depicted by figure (4.2) the localization index varies significantly among industries with water transport showing the highest localization. I control for the robustness of my results by dropping potential outliers and varying the distance of the localization index as well as weighting the 4 digit index with industry revenues based on information on the full set German firms.[10]

IV. Empirical Setup

A. Empirical Model

Following the setup by Brülhart *et al.* (2012) the process of firm foundations can be modeled as a random profit maximization problem of firm managers searching for the perfect location to set up a new firm among a given set of locations. Given the profit π_{fijt} of firm f in industry j, location i at time t a firm will locate in municipality m if

$$\pi_{fmjt} > \pi_{fijt} \ \forall \ i, i \neq m \tag{4.5}$$

by Bureau van Dijk. The data is not available on a municipality level.

[10]Revenues per industry are based on the DAFNE data set for the year 2009 provided by Bureau van Dijk.

The profit may be defined by a deterministic part U_{ijt} and a random error ϵ_{fijt}

$$\pi_{fijt} = U_{ijt} + \epsilon_{fijt}. \tag{4.6}$$

The deterministic part of the model captures location and industry specific factors. I assume that the deterministic part is given by a linear relationship of taxes T_{it}, public capital stock C_{it} and socio-economic variables $\mathbf{X}_{ijt}$. Additionally, in the spirit of the "new economic geography" literature, firms of an industry j locating in a specific municipality benefit from localization L_j of industry j which effects profits directly and via the interaction with the tax rate and capital stock.[11] In summary, the profit function (4.6) can be written as

$$\pi_{fijt} = U_{ijt} + \epsilon_{fijt} = \alpha_1 T_{it} + \alpha_2 T_{it} L_j + \beta_1 C_{it} + \beta_2 C_{it} L_j + \gamma L_j + \delta \mathbf{X}_{ijt} + \epsilon_{fijt}. \tag{4.7}$$

The coefficients of interest are α_1, α_2, β_1 and β_2. Based on previous research on the effects of taxation on firm foundations I expect α_1 to be negative (see Devereux and Maffini (2007) for a survey). Furthermore, I expect the effect of the capital stock on firm foundations to be positive. Generally speaking, if the capital stock has a positive effect on firms productivity, firms are more willing to locate in municipalities with an optimal amount of expenditures. Hence, I would identify a positive and significant point estimate. The coefficients α_2 and β_2 capture the interaction effect of localization and the business tax rate or capital stock. Given a negative effect of taxation on firm foundations, a positive coefficient α_2 represents a decreasing tax effect with stronger localization. Thus, the sensitivity of firm foundations to changes of the local business tax would be mitigated by increasing localization. This result has been confirmed by Brülhart *et al.* (2012) using a sample of firm foundations in Switzerland. The direction of the interaction effect of localization and the capital stock is previously unknown. A positive interaction effect would indicate that localization effects increase the benefits of the capital stock on firm productivity.

[11]Note that I assume that localization affects the sensitivity of firm foundations to changes of the tax rate or capital stock. This assumption will be tested in the empirical model. If point estimates are significant the assumption is valid.

Hence, firm foundations in strongly localized industries would be more sensitive to changes of the capital stock. A negative interaction effect can be interpreted as offsetting the positive effect of PIGS provision because firms benefit strongly by locating in localized areas and are less sensitive to changes of the capital stock.

Following McFadden (1974) assuming that the stochastic error follows an extrem-value type 1 distribution gives the probability of choosing location m as

$$P_{mjt} = e^{U_{mjt}} \left(\sum_{j} e^{U_{ijt}} \right)^{-1}. \tag{4.8}$$

Furthermore, define

$$d_{fijt} = \begin{cases} 1 & \text{if } f \text{ chooses } i \\ 0 & \text{otherwise} \end{cases} \tag{4.9}$$

and the log-likelihood of the conditional-logit model is given by

$$ln(L) = \sum_{f} \sum_{i} \sum_{j} \sum_{t} d_{fijt} ln(p_{ijt}) = \sum_{i} \sum_{j} \sum_{t} n_{ijt} ln(p_{ijt}) \tag{4.10}$$

with $n_{ijt} = \sum_f d_{fijt}$ the number of firms in municipality i and industry j at time t.[12] The log-likelihood of a Poisson regression on the number of firm foundations gives the same (up to a constant) log-likelihood function as the conditional-logit model (see Guimarães *et al.* (2003) for details). Therefore, the location choice can be represented by a Poisson regression of

$$E\left[n_{ijt}|R_{ijt}\right] = exp\left(\alpha_1 T_{it} + \alpha_2 T_{it} L_j + \beta_1 C_{it} + \beta_2 C_{it} L_j + \delta \mathbf{X}_{ijt} + \lambda_i + \nu_j + \kappa_t\right) \tag{4.11}$$

with λ_i municipality, ν_j industry and κ_t time fixed effects (absorbing γL_j in equation (4.7)).[13]

Following Becker and Henderson (2000) or Figueiredo *et al.* (2002) the model of firm birth could also be represented by a model where entrepreneurs are spatially

[12] Equation (4.10) assumes that firm decisions are solely based on industry and location specific characteristics that are common to all firms.

[13] $R_{ijt} = [T_{it}, E_{it}, L_j, \mathbf{X}_{ijt}]$ being the set of explanatory variables.

immobile and repeatedly decide if they want to set up a new firm. Note that the latter can also be represented by a Poisson model.[14]

B. Empirical Obstacles

Estimating the empirical model assumes exogeneity of all explanatory variables. The focus of this article is on the (interaction) effects of taxation, PIGS provision and localization on firms' location choice. While tax rates and PIGS provision are likely to affect the number of firm foundations, the number of firms in a municipality is vice versa also likely to affect the tax rate and the level PIGS provision through the local tax base. Moreover, anecdotal evidence suggests that the size and number of firms may influence localities' policies, e.g. by stronger investments in lobbying. So far, only scarce work testing this hypothesis exist (see e.g. Brülhart and Simpson 2018, for a recent discussion). By using the count of new firms registering in a municipality concerns of simultaneity bias with regard to municipalities policies and thus the tax rate and expenditures can be mitigated. It is unlikely that new firms who have not earned any revenues and thus haven't paid taxes at the time of birth have a direct effect on the tax rate and expenditures. On top, lobbying is more likely to occur among established corporations. Nevertheless, as the count of new firms is dependent on the count of existing firms an indirect effect might create biased results. This concern is addressed using an instrumental variable approach.

Moreover, localization is a direct function of the number of firms that are geographically located. As stated in section III the measure of localization is based on the stock of firms in 1999 and constant over time. Thus, this obstacle is addressed as the localization index used for the empirical analysis is independent of the number of firm foundations.

Equation (4.11) assumes that the sensitivity of the number of firm foundations to changes in locations' taxation and PIGS provision is linear and continues. In

[14] According to Brülhart *et al.* (2012) this is a considerable advantage given that with limited information finding the best model for the actual data-generating process is infeasible.

contrast, models in the tradition of Krugman (1991) mostly assume a discontinuous relation between agglomeration and taxation (or public spending). If localization exceeds a specific threshold, all firms of a mobile industry locate in one location. On top, the construction of the localization index does not take into account the number of alternative locations when firms enter the market. For example, note that water transport is among the most localized industries. While it seems possible that firms which are active in water transport benefit from locating close to each other, it is more likely that the localization index is high due to a small number of possible locations.[15] To address these theoretical considerations I cut the localization index at top quantile thresholds to check for robustness. Note that explicitly controlling for non-linearities of the interaction is beyond the scope of this article.

Additionally, I control for violations of the equidispersion assumption of the underlying Poisson distribution calculating robust standard errors (see Wooldridge 2010, for a discussion). Specifically, if the equidispersion assumption ($E(n_{ijt}) = Var(n_{ijt})$) of the dependent variable is violated the Poisson model generates a false covariance matrix and hypotheses tests are invalid. By using robust standard errors this assumption is relaxed and the estimated covariance matrix is valid.

C. Instruments

I will instrument the capital stock using two instruments.

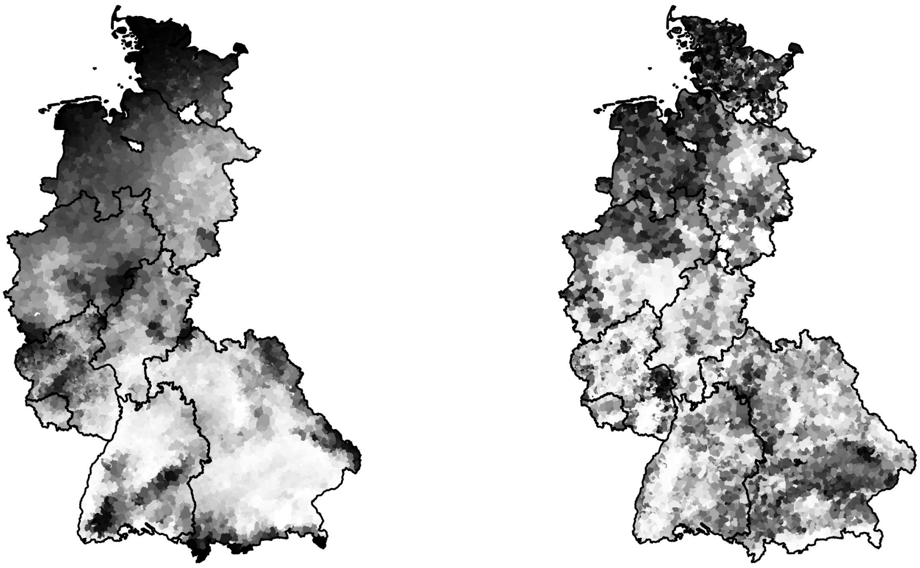
The first exploits variation generated by the 'Renewable Energy Sources Act' (RES Act) of 2000. This Act was initiated by the German state to promote energy production from renewable sources. Among others, the law created heavy subsidies for firms constructing wind power plants resulting in a substantial increase in the number of plants across Germany. Wind power plants are subject to local taxation and directly increase local trade tax and property tax revenues. Note that to maximize energy output wind power plants are build in areas with high wind strength and

[15]Note that a limited number of alternative locations also limits the sensitivity to changes of local taxation and PIGS provision.

sufficient free/unpopulated space. The guideline for approving the construction of wind power plants in Germany states that the typical distance of an energy production area with 7 wind power plants from the next local town should be at least 1500 meters.

Figure 4.3: Quantiles of Mean Wind Strength in 80 Meters Height and Mean Share of Agricultural Land

(a) Mean Wind Strength in 80m Height (b) Mean Share of Agricultural Land



Notes: The figure depicts the 1% quantiles of wind strength in 80m height and share of agricultural land in West Germany (federal states are outlined with black lines). Calculations are based on the year 2006. Darker colors are associated with higher quantiles. There exists a clear difference between North and South Germany with more wind and agricultural land in Lower Saxony and Schleswig-Holstein. To address concerns about the differences between federal states I include state times year fixed effects in the regressions.

To construct the instrument I will use the mean wind strength (from 1981 to 2000) in a height of 80 meters and the total agricultural land in *ha* of a municipality. Figure 4.3 depicts 1% quantiles of both variables. Darker colors are associated with higher quantiles. The figure suggests that wind strength and agricultural land vary substantially between localities. The figures imply that localities in the north of the country (especially in Lower-Saxony and Schleswig-Holstein) are more likely to host wind power plants. To construct the instrument, the two variables (wind and agricultural land) are multiplied with a dummy taking the value 1 after the year 2000. Further I construct the interactions between both variables. I expect municipalities with suitable wind power and agricultural land to have benefited from the renewable energy sources act. Hence, the two-way interaction serves as our instrument while I control for mean wind strength after the reform. Additionally, the instrument is multiplied with a time trend to capture delayed effects.

The local business tax is instrumented using a dummy indicating derivations from a so-called reference tax rate. Public revenues are redistributed among municipalities within federal states to equalize funds per capita and to harmonize the availability of public goods. Redistribution is based on a complicated system. In short, the system calculates the financial requirements and the financial potential of every municipality based on various statistical indicators. Differences between financial requirements and potentials are then mitigated by fiscal redistribution. Among other indicators, federal states calculate a reference business tax rate based on the potential taxable capacity for every municipality. Hence, if municipalities set a low business tax rate to attract mobile capital the potential loss in business tax revenues is not necessarily negated with fiscal redistribution as the federal government assumes that the local business tax rate could have been higher and the difference between financial requirement and potential can be mitigated by a higher tax rate. Our instrument is a dummy indicating if the local business tax in 1998 was below or above the actual reference tax. If the reference tax exceeds (falls short from) the local business tax in 1998, local business tax rates are expected to have increased (fallen) to mitigate the difference between financial requirement and potential. We control for the robustness of the instrument by adding state times year fixed effects to validate if variation within states and year of the dummy is sufficient to instrument the trade tax rate.

V. Empirical Results

In what follows I will present the empirical results. As outlined in section IV the process of firm foundations can be represented by a log-linear relationship that can be estimated using a Poisson model. Poisson models are naturally hard to interpret. Hence, I additionally estimate the log-linear relationship using simple OLS estimation after log-transforming the dependent variable. Note that this approach creates missing data for municipalities, industries and years with zero firm births which leads to a substantial loss of observations.[16] Moreover, interpretation is conditional on the sample of municipalities with at least one firm of a given industry and year locating in this municipality. Hence, as firm entry comes at fixed costs (or sunk costs) that are lost if the firm exits or relocates in subsequent years, I expect point estimates for a sample of existing firms to be smaller compared to the full sample. On the other hand using a linear regression allows to control for the relevance of the instruments.

A. Log-Linear Model

Table (4.3) depicts the results using a log-linear model regressing the log number of new firms on the (log) local business tax and (log) capital stock of economic promotion. Specification (1) shows the OLS estimate. The effect of taxation and economic promotion is insignificant. On top, the point estimate for economic promotion is negative and basically zero. Specification (2) shows the two-stage-least-squares estimates of the variables of interest. First stage results are reported in Table (4.7) in Appendix A. The point estimate of the reference tax dummy is positive and significant. On top, the capital stock for economic promotion increases with higher wind strength and agricultural land.[17] Using the Kleibergen and Paap (2006) rank

[16] Approximately 3,000 municipalities are dropped from the regression when taking the logarithm of firm foundations.

[17] Note that the first stage results show that the positive effect of wind strength and agricultural land is mitigated over time. This is based on the fact that the log-sample does not include small (in terms of population and firm foundations) municipalities and the increase of economic promotion in larger municipalities after 2000 does not persist over time. Using the same instrumentation in the Poisson sample including all municipalities gives a positive effect over time.

F-statistic for weak instruments supports the assumption of valid excluded instruments (in all specifications) as it exceeds a rule-of-thumb value of 10. Moreover, the Hansen test for over-identifying restrictions cannot be rejected, which means the exogeneity of one instrument given the exogeneity of the other cannot be rejected. Increasing the local business tax multiplier by 1% decreases the number of firm foundations (in municipalities with at least one firm foundation) by 1.8%. A 1% increase of the capital stock of economic promotion increases the number of new firms by 0.24%. The interaction effects are positive but insignificant. To address potential concerns regarding the validity of both instruments I include state times year fixed effects in specification (3). The point estimates for economic promotion and the interaction effects are barely affected while the point estimate for the tax rate drops to 1.07%. As depicted in section III the localization index for the top three localized industries differ substantially from the average localization. To address concerns whether the estimates are biased due to outliers and to check for discontinuity of localization I drop observations (industries) with a localization index above the 95% and 90% quantile. Specifications (4) and (5) depict the results including state times year fixed effects. The tax effect is negative and significant ranging from 1.25% to 1.55%. Economic promotion is positive and significant around 0.25%. Most notably the interaction effect of the tax rate and localization index increases and turns significant. Hence, with increasing localization the negative effects of taxation are mitigated. These results are in line with Brülhart *et al.* (2012). Note that the interaction effect of economic promotion turns negative but stays insignificant.

Using an alternative weighting scheme for the localization index (specifications (6) and (7)) gives comparable results. However, weighting the localization by revenues gives a significant and negative point estimate for the interaction effect of economic promotion and localization. Hence, the positive effect of economic promotion decreases with localization. Based on the point estimates I conclude that while the local business tax has a negative and economic promotion has a positive effect on the number of firm foundations, the sensitivity decreases with increasing localization economies.

Table 4.3: Log-Linear Models

	Dependent Variable: ln(Number of Firm Foundations)						
	Weighted Localization Index					Revenue Weighted Localization Index	
				Cut Pctl(95%)	Cut Pctl(90%)		Cut Pctl(90%)
	OLS (1)	2SLS (2)	2SLS (3)	2SLS (4)	2SLS (5)	2SLS (6)	2SLS (7)
ln(Local Business Tax)	-0.027	-1.800***	-1.070*	-1.251**	-1.550***	-1.134**	-1.613***
	(0.041)	(0.466)	(0.563)	(0.564)	(0.589)	(0.564)	(0.612)
LOC X ln(Local Business Tax)		73.782	71.932	173.236**	341.106***	95.564	313.029***
		(88.011)	(86.418)	(85.426)	(117.083)	(62.873)	(103.271)
ln(Economic Promotion)	-0.001	0.238***	0.230***	0.245***	0.223***	0.252***	0.252***
	(0.003)	(0.061)	(0.070)	(0.071)	(0.071)	(0.071)	(0.073)
LOC X ln(Economic Promotion)		1.896	1.930	-3.056	-5.500	-8.927**	-18.626***
		(4.878)	(4.797)	(4.771)	(6.391)	(3.519)	(5.616)
N	257030	257030	257030	256556	241833	257030	230790
log-likelihood	-206567.58	-211770.83	-209453.26	-208962.69	-197089.07	-210333.83	-190433.84
F	6.12***	11.54***	10.33***	12.65***	11.63***	8.99***	7.54***
Underidentification LM		346.06	320.48	316.45	298.49	313.68	283.03
Weak Instrument Test†		56.20	53.15	52.52	49.43	52.03	46.76
Hansen p-value		0.61	0.24	0.09	0.52	0.20	0.33
Municipality Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State X Year Fixed Effects			Yes	Yes	Yes	Yes	Yes

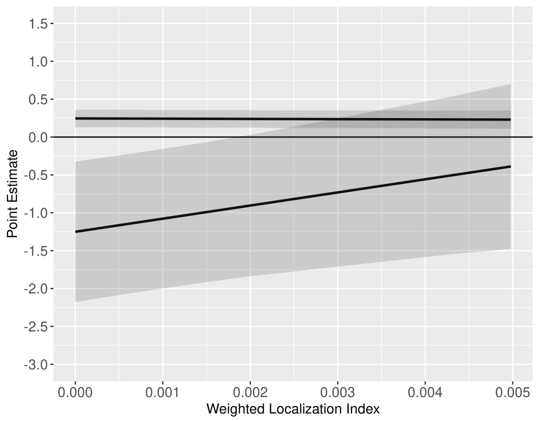
*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$. *Source:* Own data collection and calculations. *Notes:* Economic promotion in one million. Eicker-White robust standard errors are in parentheses. †Kleibergen and Paap (2006) rank F-statistic for stationary data.

Figures (4.4a) and (4.4b) depict the effects of specification (4) and (7) graphically over the range of localization. As can be seen, for both specifications the negative tax rate effect decreases with increasing localization and turns insignificant around 0.00175. The point estimate for economic promotion stays positive and significant over the whole range of localization.

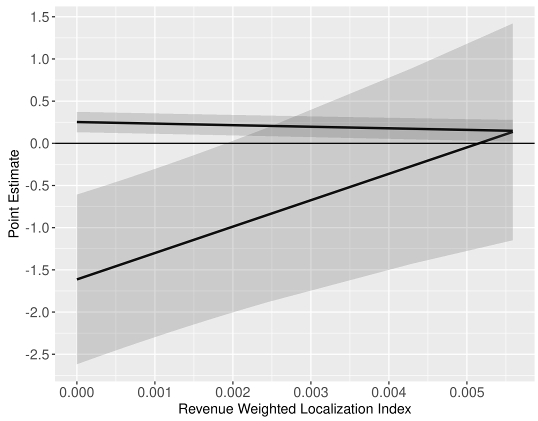
B. Poisson Model

The log-linear models do not use the full sample as observations with zero firm foundations are dropped from the regression. Moreover, section IV shows that firm foundation rates can be adequately modeled using a Poisson model. Therefore, I estimate the effects of taxation, PIGS provision and localization using a Poisson estimation. Table (4.4) depicts the estimation results. Specification (1) depicts the point estimates without instrumenting the endogenous regressors. I identify a positive and significant effect of economic promotion with a point estimate of 0.003 and a negative and significant effect of the local business tax rate of 0.001. Thus, both effects behave as expected with an increase in local taxation reducing the expected number of firm foundations while additional expenditures for economic promotion increase the latter. Poisson estimates cannot, unlike the OLS coefficients, be in-

Figure 4.4: Tax Rate and Economic Promotion Effect (2SLS Estimates)



(a) Weighted Localization Index cut at the 95% Quantile.



(b) Revenue Weighted Localization Index cut at the 90% Quantile.

Notes: The figures depict the effects of a 1% increase in a locations tax rate (bottom line) and capital stock of economic promotion (top line) on the number of firm foundations in an industry and year using a log-linear regression. The coefficients are based on the estimates and standard errors of table (4.3), speficiations (4) and (7). The shaded areas represent 90% confidence intervals.

terpreted as marginal effects. However, they can be interpreted as semielasticities or proportional changes of the expected number of firm foundations. Taking the estimation equation given by equation (4.11) and calculating the derivative with respect to the tax rate T_{ijt} gives[18]

$$\frac{\partial n_{ijt}}{\partial T_{ijt}} = (\alpha_1 + \alpha_2 L_j)\, n_{ijt}$$
$$\Rightarrow \frac{\partial n_{ijt}/n_{ijt}}{\partial T_{ijt}} = (\alpha_1 + \alpha_2 L_j)\,. \tag{4.12}$$

Thus, the effect of an increase of the local business tax rate depends on the strength of localization in the industry. I find a positive but insignificant effect of the localization index and tax rate. On top, I identify a positive and significant point estimate of the interaction effect of localization and economic promotion. Thus, using simple Poisson estimation I would conclude that the positive effect of economic promotion increases with localization. An increase in the mean local business tax rate by 1% in an industry without localization decreases the expected number of new firm foundations proportional by 0.339% (3.39 × 0.1%). Simultaneously, an increase of the capital stock of economic promotion by 1% increases the expected number of new

[18]Calculations for the capital stock are analogous.

firms in an industry without localization by 0.00423% ($0.0141 \times 0.3\%$) which is close to zero.

Drawing conclusions on these results are hazardous as PIGS provision and taxation are unlikely to be exogenous in the empirical setup. Therefore, from specification (2) onward I continue using a control function approach to address the estimation obstacles of endogenous regressors outlined in section IV. Equations (4.13) show the general idea with Y_1 the dependent variable, Y_2 an endogenous variable, Z the excluded instruments and X a set of exogenous control variables. Hence, in the first step I separately regress the local business tax rate, PIGS provision and the interaction effects on the set of excluded instruments and exogenous variables using simple ordinary least squares regressions and calculate the residuals. In a second step I estimate the Poisson model including the endogenous and exogenous variables as well as the calculated (first stage) residuals. Following Wooldridge (2010) this method generates unbiased estimates of the point estimates. Standard errors are bootstrapped with 50 draws to obtain valid standard errors and clustered on the municipality and industry level to control for violations of the underlying Poisson distribution.

$$\begin{aligned} &\text{First Stage (OLS):} && Y_2 = \mathbf{X}\beta + \mathbf{Z}\gamma + \nu \\ &\text{Second Stage (Poisson):} && E\left[Y_1 | \mathbf{X}, Y_2\right] = \exp\left(X\beta + \delta Y_2 + \nu\right) \end{aligned} \tag{4.13}$$

First stage results of equation (4.13) can be found in Table (4.8) of Appendix A.[19] The point estimates of the excluded instruments behave as expected. Municipalities with a higher average wind strength and sufficient agricultural land to host wind power plants show higher expenditures after the RES Act of 2000. On top, the dummy for the reference tax multiplier is positive. Hence, if municipalities have a higher taxable capacity compared to 1998 they are more likely to have increased the current local business tax.

[19] I only report the first stage results of specification (3) of table (4.4). Note that the results do not significantly differ between specifications.

Table 4.4: Poisson Models

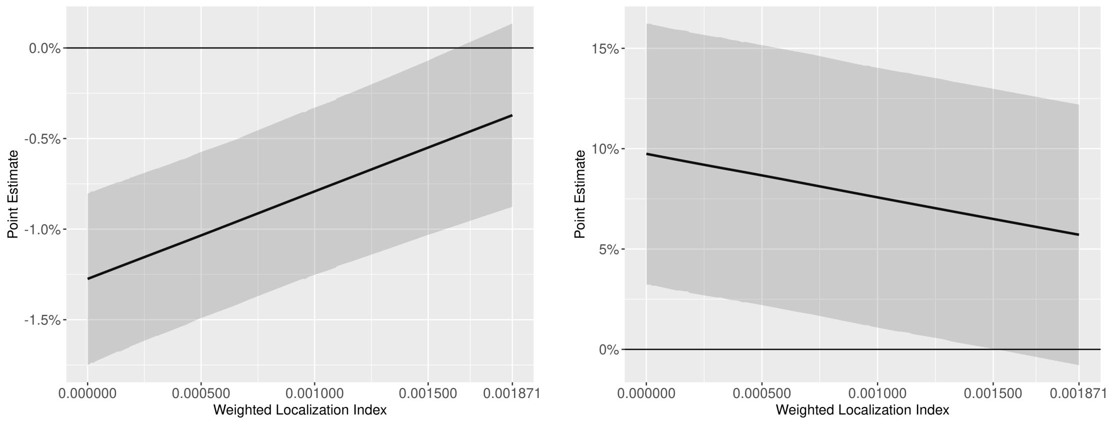
	Dependent Variable: Number of Firm Foundations						
	Weighted Localization Index					Revenue Weighted Localization Index	
			Cut Pctl(90%)			Cut Pctl(90%)	
	Poisson (1)	CF (2)	CF (3)	CF (4)	CF (5)	CF (6)	CF (7)
Local Business Tax	-0.001***	-0.008***	-0.013***	-0.013***	-0.011***	-0.014***	-0.015***
	(0.000)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)
LOC X Local Business Tax	0.020	-0.241	4.931***	5.111***	5.172***	5.365***	5.404***
	(0.069)	(1.428)	(1.642)	(1.725)	(1.658)	(1.819)	(0.948)
Economic Promotion	0.003**	0.072**	0.099***			0.085**	
	(0.001)	(0.035)	(0.038)			(0.039)	
LOC X Economic Promotion	0.318***	4.088	-22.773***			- 24.233***	
	(0.082)	(5.369)	(5.598)			(6.450)	
Total Capital Stock				0.013*			0.008
				(0.007)			(0.006)
LOC X Total Capital Stock				-1.518***			-1.475***
				(0.396)			(0.192)
Expenditures					0.015**		
					(0.006)		
LOC X Expenditures					-3.892***		
					(0.960)		
N	2,866,802	2,866,802	2,577,383	2,577,383	2,577,087	2,575,829	2,575,829
Municipality Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Industry Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Year Fixed Effects	✓	✓	✓	✓	✓	✓	✓
State X Year Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Controls		✓	✓	✓	✓	✓	✓
Bootstrapped SE		✓	✓	✓	✓	✓	✓
# of Bootstraps		50	50	50	50	50	50

*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$. *Source:* Own data collection and calculations. *Notes:* Bootstrapped and clustered standard errors are in parentheses.

Instrumenting the tax rate increases the point estimate approximately by the factor 8. An increase of the average local business tax rate by 1% decreases the expected number of firm foundations in non-localized industries by approximately 2.7%. The interaction effect turns negative but stays insignificant. An increase in average expenditures for economic promotion increase the expected number of firm foundations in non-localized industries by 0.1%. This is a substantial increase compared to the uninstrumented specification. The interaction effect stays positive but turns insignificant. As outline before, outliers and nonlinearities in the localization index are likely to distort the results of the interaction effects. Therefore, I cut the localization index at the 90% quantile. Results are depicted in specification (3). The point estimates of the local business tax rate and economic promotion are only marginally affected. On top, the interaction effects increase substantially and turn significant. Hence, stronger localization mitigates the negative tax effect and the positive effect of economic promotion. While the expected number of industries without localization decrease by 4.4% for a 1% increase of the average tax rate the decrease in industries with strong localization (e.g. 0.001871) is 1.34%. A 1% increase of (average) economic promotion increases the expected number of firm

Figure 4.5: Implied Tax and PIGS Effect (Poisson Model)

(a) Local Business Tax (b) Economic Promotion



foundations in non-localized industries by 0.13% and in strongly localized industries by 0.08%. Hence, the stronger localization the less sensitive are firm foundations to an increase in the tax rate or PIGS provision. The results are robust against using a revenue weighted localization index (see specification (6)).

Additionally, I estimate the effects of the total capital stock using both localization indexes (see specifications (4) and (7)). While the point estimates for the local business tax are unaffected, the point estimates for the total capital stock are somewhat smaller compared to economic promotion. Both are positive and significant. Hence, a 1% increase of the mean total capital stock increases the expected number of new firm foundations in a non-localized industry proportional by approximately 0.35% (or 0.24% for a revenue weighted localization index). Both effects decrease with increasing localization. Thus, as in the regression with economic promotion, the sensitivity of firm foundations to changes in the total capital stock decreases with stronger localization in an industry.

To assess the robustness of the empirical setup with respect to my definition of the capital stock I estimate the model using overall current (voluntary) expenditures (see specification (5)). The results and implications are comparable to the estimates using the total capital stock.

Using the conditional-logit interpretation of the Poisson model the estimates can also be used to predict changes in the probability that a firm chooses municipality

i in industry j at time t if municipalities increase the local business tax or PIGS provision. Using the first derivative of the probability given by equation (4.8) with respect to the local business tax rate (or capital stock) gives

$$\frac{\partial P_{ijt}}{\partial T_{it}} = \frac{(\alpha_1 + \alpha_2 L_j)\, e^{U_{ijt}} \sum_i e^{U_{ijt}} - (\alpha_1 + \alpha_2 L_j) \left(e^{U_{ijt}}\right)^2}{\left(\sum_i e^{U_{ijt}}\right)^2}$$
$$= (\alpha_1 + \alpha_2 L_j)\, P_{ijt}\, (1 - P_{ijt})\,. \tag{4.14}$$

Hence, the change in the probability that new firms locate in municipality i at time t does not only depend on the estimated coefficients α_1 and α_2 (or β_1 and β_2) and the localization index L_j but also on the choice probability that a firm of industry j is willing to locate in municipality i at time t. Figure (4.5) depicts (using the point estimates of specification (3)) the calculated probability changes for different localization values in a representative municipality and year if the local business tax rate (figure (4.5a)) or capital stock of economic promotion (figure (4.5b)) increase by 1%.[20] A 1% increase in the local business tax rate in Thedinghausen decreases the probability that a firm of the wholesale and retail trade industry locates in this municipality by 1.25%. On the other hand, a 1% increase of the capital stock of economic promotion increases the probability of a firm in this industry to locate in Thedinghausen by almost 10%. Although this effects seems substantial at first glance note that in 2000 no firms of the wholesale and retail trade industry (and only 20 firms of all industries) located in Thedinghausen. The calculated probability that a firm of this industry located in this municipality is approximately 0.015%. Both effects are mitigated by increasing localization economies. The effect on an industry with strong localization, e.g. on firms that provide service activities for business (with a localization index of 0.001871), is −0.3% or 5.7% receptively. Note that both effects are insignificant (using a 95% confidence interval).

To sum up, while Poisson regressions do identify a negative effect of an increase

[20]The representative municipality is Thedinghausen (Lower-Saxony) in 2000. It is representative such that the exogenous variables for this municipality and year are close to the sample mean of every variable.

in the local business tax and a positive effect of an increase in PIGS provision, both effects decrease with increasing localization economies.[21] On top, both effects turn insignificant for the top localized industries. Thus, localization can mitigate the negative effects (positive effects) of taxation (PIGS) as spillover effects between localized industries become more important and firms react less sensitive to changes of municipalities policies. In addition, this results imply that localization creates possibilities for municipalities to tax agglomerations rents as discussed by Koh *et al.* (2013).

VI. Results with Varying Localization Distances

As presented in section III the localization index can be constructed for any distance d. So far, the empirical results use a localization index based on distances of firms in an industry that lie within the same municipality.[22] Hence, it assumes that localization economies are limited by administrative boundaries. However, the institutional setting in West Germany consists of many small municipalities and spillover effects are likely to cross those boundaries.[23] The following results estimate log-linear models (like specification (5) of table (4.3)) and Poisson models (like specification (3) of table (4.4)) using a localization index within distances up to 30km to control for boundary crossing localization economies.

Table (4.5) depicts the results with specification (1) to (3) using a (simple) weighted average localization index and specifications (4) to (6) using a revenue weighted localization index applying log-linear regressions. The point estimates for the local business tax and economic promotion are overall robust against increasing the distance and comparable to the results of Table (4.3). A 1% increase of the local business tax rate decreases the expected number of firm foundations between

[21] The effects are identified if the localization is cut at the 90% quantile to exclude outliers.

[22] The distance of firms that locate in the same municipality is zero by construction.

[23] The average area of German municipalities is 29 km^2. Assuming that institutional boundaries are circular, the average municipality has a diameter of 6km. Note however, that this varies greatly with federal states as the municipality area in my sample ranges from 0.39 km^2 (Martinstein) at the minimum to 357.5 km^2 (Neustadt am Rübenberge) at the maximum.

Table 4.5: Log-Linear Models with Varying Localization Distance from 5km to 30km.

	Dependent Variable: ln(Number of Firm Foundations)					
	Weighted Localization Index			Revenue Weighted Localization Index		
	5km (1)	10km (2)	30km (3)	5km (4)	10km (5)	30km (6)
ln(Local Business Tax)	-1.469**	-1.544**	-1.701***	-1.505**	-1.506**	-1.495**
	(0.607)	(0.609)	(0.612)	(0.609)	(0.610)	(0.610)
LOC X ln(Local Business Tax)	65.118*	53.640**	39.227***	49.089***	28.411***	12.175***
	(34.331)	(22.278)	(11.922)	(17.491)	(9.917)	(4.631)
ln(Economic Promotion)	0.205***	0.219***	0.265***	0.240***	0.247***	0.268***
	(0.072)	(0.073)	(0.074)	(0.073)	(0.073)	(0.074)
LOC X ln(Economic Promotion)	5.704***	0.793	-2.947***	-3.025***	-2.431***	-1.857***
	(1.744)	(1.161)	(0.639)	(0.948)	(0.544)	(0.258)
N	229370	229370	229370	229370	229370	229370
log-likelihood	-187594.23	-188155.17	-189783.38	-188807.70	-189007.27	-189368.59
F	25.48***	14.07***	10.38***	7.44***	9.60***	26.24***
Weak Instrument Test†	48.71	48.86	49.15	48.03	48.01	47.96
Hansen p-value	0.55	0.52	0.46	0.32	0.36	0.48
Controls	✓	✓	✓	✓	✓	✓
Municipality Fixed Effects	✓	✓	✓	✓	✓	✓
Industry Fixed Effects	✓	✓	✓	✓	✓	✓
Year Fixed Effects	✓	✓	✓	✓	✓	✓
State X Year Fixed Effects	✓	✓	✓	✓	✓	✓

*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$. *Source:* Own data collection and calculations. *Notes:* Economic promotion in one million. Eicker-White robust standard errors are in parentheses. †Kleibergen and Paap (2006) rank F-statistic for stationary data.

1.5% and 1.7% for an industry with no localization. A 1% increase of the stock of economic promotion increases the number of firm foundations in industries without localization by 0.21% to 0.27%. The interaction effect of localization and the tax rate is positive and significant for all localization indexes. Hence, firms of an industry with strong localization are less sensitive to changes of the local business tax. The interaction effect of localization and economic promotion is positive and significant for the weighted localization index within 5km distance. It turns negative with increasing distance and is negative and significant for all distances using a revenue weighted localization index. Thus, the robustness checks find evidence for both increasing and decreasing sensitivity of firms to expenditures for economic promotion. However, note that the size of the interaction effect is small such that the differences in the sensitivity to expenditures for economic promotion are negligible between weakly and strongly localized industries.

Additionally, I do control for the robustness of the results using different distances of the localization index in the Poisson model. The results are depicted in table (4.6). Increasing the distance of the localization index for the Poisson models supports the results of the baseline regression. All specifications identify a negative effect of the local business tax and a positive effect of economic promotion (for low localized industries). On top, both effects decrease with increasing localization. Not that the

Table 4.6: Poisson Models with Varying Localization Distance from 5km to 30km cut at the 90% Quantile

	Dependent Variable: Number of Firm Foundations					
	Weighted Localization Index			Revenue Weighted Localization Index		
	5km (1)	10km (2)	30km (3)	5km (4)	10km (5)	30km (6)
Local Business Tax	-0.014***	-0.015***	-0.011***	-0.014***	-0.015***	-0.011***
	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.004)
LOC X Local Business Tax	0.995***	0.732***	0.158	0.976***	0.651***	0.104
	(0.286)	(0.214)	(0.158)	(0.234)	(0.146)	(0.134)
Economic Promotion	0.100**	0.090**	0.079*	0.088***	0.083***	0.066*
	(0.048)	(0.040)	(0.044)	(0.031)	(0.031)	(0.034)
LOC X Economic Promotion	-4.581***	-3.311***	-0.887*	-4.365***	-2.881***	-0.611
	(0.998)	(0.662)	(0.501)	(0.889)	(0.569)	(0.383)
N	2,507,724	2,577,383	2,512,080	2,505,564	2,505,564	2,579,973
Municipality Fixed Effects	✓	✓	✓	✓	✓	✓
Industry Fixed Effects	✓	✓	✓	✓	✓	✓
Year Fixed Effects	✓	✓	✓	✓	✓	✓
State X Year Fixed Effects	✓	✓	✓	✓	✓	✓
Instrument Controls	✓	✓	✓	✓	✓	✓
Control Function Residuals	✓	✓	✓	✓	✓	✓
Bootstrapped SE	✓	✓	✓	✓	✓	✓
# of Bootstraps	50	50	50	50	50	50

*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$. *Source:* Own data collection and calculations. *Notes:* Economic promotion in one million. Bootstrapped and clustered standard errors are in parentheses.

decrease is smaller the larger the distance and turns insignificant for localization economies within 30km. The latter is based on the fact that localization economies within 30km are beneficial for firms in multiple municipalities. Hence, firms who are willing to set up a firm or move their existing establishment in another municipality as a reaction to changes in the local business tax rate or PIGS provision still benefit from the same localization economies. Thus, boundaries crossing localization economies affect the sensitivity to changes in public policies in the considered locality to a smaller extant.

VII. Conclusion

The aim of this paper was to investigate the sensitivity of firm foundations to changes of the local business tax and the provision of public goods and services (represented by the capital stock for economic promotion) with respect to the presence of localization economies. Firms location choice can be modeled using a Poisson model for the number of firm foundations. This work uses a control function approach to address concerns about the exogeneity of the tax rate and PIGS provision. I do identify a negative effect of taxation and a positive effect of economic promotion activity (or the total capital stock). The results imply that for weakly localized industries, a 1% increase of the average local business tax reduces the expected number of firm foundations by 4.4%. Simultaneously, a 1% increase of economic promotion activity increases the expected number of firm foundations by 0.13%. Both effects are mitigated by increasing localization. The effect of a 1% increase of the tax rate or PIGS provision in top localized industries is 1.34% or 0.08% respectively. Calculating the changes in the probability of firm foundations in a representative municipality for non-localized industries, I identify a decrease of 1.25% for a 1% increase of the local business tax and a 10% increase for a 1% increase in economic promotion activity. Both effects decrease and turn insignificant for strongly localized industries. Hence, I conclude that the sensitivity to changes of the local business tax and the provision of PIGS decrease with increasing localization economies.

This work contributes to the open discussion on strategic tax setting of local governments. Theoretical work predicts a "race to the bottom" of local tax rates if jurisdictions compete for mobile capital (see Wilson 1999, for a review). While many empirical tests of this theory find contradicting results (Buettner 2003, Baskaran 2014), the literature on "new economic geography" might provide answers. This work contributes as it quantifies the reduction in the sensitivity of firms to changes of local tax rates and PIGS provision. If the sensitivity decreases significantly and turns insignificant for strongly localized industries competition among local governments for mobile capital is suspended. Hence, further reduction of the tax rate does not necessarily increase the number of firm foundations and stops the race. Moreover, the positive effect of PIGS provision is limited by localization economies and thus might set a natural limit to the effectiveness of public investment to foster regional growth.

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Appendix A: First Stage Regressions

Table 4.7: First Stage of the Log-Linear Regression

Dependent Variable	ln(Tax)	LOC X ln(Tax)	ln(EP)	LOC X ln(EP)
	(1)	(2)	(3)	(4)
Wind X ln(AGR) X Reform	0.0003**	-0.0000***	0.0031***	-0.0001***
	(0.0001)	(0.0000)	(0.0005)	(0.0000)
LOC X Wind X ln(AGR) X Reform	0.0681	0.0044***	0.0520	0.1111***
	(0.0425)	(0.0004)	(0.1820)	(0.0030)
Wind X ln(AGR) X Reform X Trend	-0.0001***	-0.0000**	-0.0023***	-0.0000**
	(0.0000)	(0.0000)	(0.0001)	(0.0000)
LOC X Wind X ln(AGR) X Reform X Trend	-0.0231	0.0000	-0.0119	-0.0010
	(0.0151)	(0.0001)	(0.0496)	(0.0008)
Reference Tax Dummy	0.0265***	0.0001***	0.0248***	0.0010***
	(0.0009)	(0.0000)	(0.0084)	(0.0001)
LOC X Reference Tax Dummy	0.1009	-0.0697***	-0.8597	-0.9617***
	(0.3197)	(0.0017)	(1.4779)	(0.0215)
ln(Population in 1000)	0.0094	0.0000	0.0761*	0.0003
	(0.0361)	(0.0001)	(0.0457)	(0.0003)
ln(Unemployment Rate)	0.0042***	0.0000	0.1500***	0.0002***
	(0.0006)	(0.0000)	(0.0092)	(0.0001)
Share Low Qualified Workers in %	-0.0009***	-0.0000	0.0457***	0.0000***
	(0.0001)	(0.0000)	(0.0018)	(0.0000)
Share Medium Qualified Workers in %	0.0005	0.0000	0.0289***	0.0000**
	(0.0004)	(0.0000)	(0.0014)	(0.0000)
Share High Qualified Workers in %	-0.0015***	-0.0000	0.0518***	0.0000**
	(0.0002)	(0.0000)	(0.0032)	(0.0000)
ln(Students)	-0.0030***	-0.0000**	-0.0183***	-0.0000
	(0.0002)	(0.0000)	(0.0029)	(0.0000)
ln(Doctors)	-0.0266***	-0.0000**	-0.0505*	-0.0003
	(0.0027)	(0.0000)	(0.0263)	(0.0002)
Wind X Reform	-0.0169***	0.0000	0.0087	0.0008***
	(0.0039)	(0.0000)	(0.0060)	(0.0000)
Wind X Reform X Trend	0.0042***	0.0000***	0.0070***	-0.0000**
	(0.0005)	(0.0000)	(0.0012)	(0.0000)
LOC X Wind X Reform	-0.5816	-0.0348***	-0.7469	-0.8334***
	(0.3679)	(0.0037)	(1.4469)	(0.0231)
LOC X Wind X Reform X Trend	0.1946	0.0014*	0.1603	0.0254***
	(0.1240)	(0.0008)	(0.3905)	(0.0061)
N	257,030	257,030	257,030	257,030
F-Statistic	175.21***	269.21***	93.47***	526.35***
Municipality Fixed Effects	✓	✓	✓	✓
Industry Fixed Effects	✓	✓	✓	✓
Year Fixed Effects	✓	✓	✓	✓
State X Year Fixed Effects	✓	✓	✓	✓

*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$. *Source:* Own data collection and calculations. *Notes:* The results depict the point estimates of the first stage of specification (3) of Table 4.3. Economic promotion (EP) is expressed in one million and local business tax (Tax) in points. Eicker-White robust standard errors are in parentheses.

Table 4.8: First Stage of the Poisson Regression

Dependent Variable:	Tax	LOC X Tax	EP	LOC X EP
	(1)	(2)	(3)	(4)
Reference Tax Dummy	10.8093***	0.0232***	0.0181***	0.0009***
	(0.0562)	(0.0003)	(0.0048)	(0.0001)
LOC X Reference Tax Dummy	-0.0000	-12.9794***	0.0000	-0.8793***
	(7.4788)	(0.0365)	(0.6385)	(0.0074)
Wind X AGR X Reform	-0.0331***	-0.0003***	0.0071***	-0.0001***
	(0.0017)	(0.0000)	(0.0001)	(0.0000)
Wind X AGR X Reform X Trend	-0.0076***	-0.0000***	0.0015***	-0.0000
	(0.0003)	(0.0000)	(0.0000)	(0.0000)
LOC X Wind X AGR X Reform	-0.0000	0.2599***	0.0000	0.1209***
	(0.6987)	(0.0034)	(0.0597)	(0.0007)
LOC X Wind X AGR X Reform X Trend	0.0000	0.0275***	-0.0000	0.0018***
	(0.1903)	(0.0009)	(0.0162)	(0.0002)
Wind X Reform	-128.5501***	0.6037***	-15.5336***	0.1898***
	(26.0739)	(0.1272)	(2.2261)	(0.0259)
Wind X Reform X Trend	285.8619***	-0.0175	-15.0772***	-0.0170***
	(4.8437)	(0.0236)	(0.4135)	(0.0048)
LOC X Wind X Reform	0.0001	-747.5128***	-0.0000	-210.1636***
	(2177.1000)	(10.6208)	(185.8736)	(2.1641)
LOC X Wind X Reform X Trend	-0.0000	303.8484***	0.0000	2.3588***
	(464.5249)	(2.2661)	(39.6596)	(0.4618)
Population in 1000	-0.0133	-0.0000	-0.0727***	-0.0001***
	(0.0197)	(0.0001)	(0.0017)	(0.0000)
Unemployment Rate	0.2182***	0.0002***	-0.0057***	-0.0000
	(0.0091)	(0.0000)	(0.0008)	(0.0000)
Share Low Qualified Workers in %	-0.0976***	-0.0001	0.0007	0.0000
	(0.0119)	(0.0001)	(0.0010)	(0.0000)
Share Medium Qualified Workers in %	0.0995***	0.0001**	0.0055***	0.0000
	(0.0091)	(0.0000)	(0.0008)	(0.0000)
Share High Qualified Workers in %	0.3486***	0.0003***	0.1799***	0.0002***
	(0.0190)	(0.0001)	(0.0016)	(0.0000)
Students	0.0118***	0.0000	0.0149***	0.0000***
	(0.0026)	(0.0000)	(0.0002)	(0.0000)
Doctors	-0.0322***	-0.0000***	0.0025***	0.0000*
	(0.0013)	(0.0000)	(0.0001)	(0.0000)
N	2,866,802	2,866,802	2,866,802	2,866,802
F-Statistic	2789.44***	14912.60***	2122.52***	8875.69***
Municipality Fixed Effects	✓	✓	✓	✓
Industry Fixed Effects	✓	✓	✓	✓
Year Fixed Effects	✓	✓	✓	✓
State X Year Fixed Effects	✓	✓	✓	✓

*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$. *Source:* Own data collection and calculations. *Notes:* The results depict the point estimates of the first stage of specification (2) of Table 4.4. Economic promotion (EP) is expressed in one million and local business tax (Tax) in points. Eicker-White robust standard errors are in parentheses.

Appendix B: Complete Estimation Tables

Table 4.9: Complete Log-Linear Models

	Dependent Variable: ln(Number of Firm Foundations)						
	Weighted Localization Index					Revenue Weighted Localization Index	
				Cut Pctl(95%)	Cut Pctl(90%)		Cut Pctl(90%)
	OLS	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
ln(Local Business Tax)	-0.027	-1.800***	-1.070*	-1.251**	-1.550***	-1.134**	-1.613***
	(0.041)	(0.466)	(0.563)	(0.564)	(0.589)	(0.564)	(0.612)
LOC X ln(Local Business Tax)		73.782	71.932	173.236**	341.106***	95.564	313.029***
		(88.011)	(86.418)	(85.426)	(117.083)	(62.873)	(103.271)
ln(Economic Promotion)	-0.001	0.238***	0.230***	0.245***	0.223***	0.252***	0.252***
	(0.003)	(0.061)	(0.070)	(0.071)	(0.071)	(0.071)	(0.073)
LOC X ln(Economic Promotion)		1.896	1.930	-3.056	-5.500	-8.927**	-18.626***
		(4.878)	(4.797)	(4.771)	(6.391)	(3.519)	(5.616)
ln(Population in 1000)	-0.049	-0.082	-0.053	-0.059	-0.062	-0.048	-0.066
	(0.059)	(0.084)	(0.070)	(0.073)	(0.079)	(0.071)	(0.082)
ln(Unemployment Rate)	-0.007	-0.067***	-0.020	-0.021	-0.014	-0.020	-0.019
	(0.012)	(0.019)	(0.015)	(0.015)	(0.016)	(0.016)	(0.016)
Share of Low Skilled Workers in %	-0.002	-0.015***	-0.012***	-0.013***	-0.013***	-0.013***	-0.015***
	(0.003)	(0.004)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Share of Medium Skilled Workers in %	0.008***	-0.002	-0.003	-0.003	-0.004	-0.003	-0.004
	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Share of High Skilled Workers in %	-0.009**	-0.023***	-0.019***	-0.020***	-0.020***	-0.019***	-0.022***
	(0.004)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.007)
ln(Students)	-0.007	-0.002	-0.001	-0.001	-0.002	-0.001	0.000
	(0.005)	(0.005)	(0.005)	(0.005)	(0.006)	(0.005)	(0.006)
ln(Doctors)	-0.029	-0.080*	-0.019	-0.022	-0.028	-0.021	-0.029
	(0.041)	(0.045)	(0.045)	(0.045)	(0.046)	(0.045)	(0.048)
Wind X Ref		-0.036***	-0.015	-0.015	-0.020	-0.015	-0.021*
		(0.011)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Wind X Ref X Trend		0.013***	0.011***	0.012***	0.012***	0.011***	0.012***
		(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
LOC X Wind X Ref		0.091	0.188	0.279	2.460***	0.525	3.581***
		(0.446)	(0.436)	(0.438)	(0.624)	(0.326)	(0.639)
LOC X Wind X Ref X Trend		-0.689***	-0.708***	-0.851***	-1.280***	-0.398***	-0.915***
		(0.097)	(0.095)	(0.093)	(0.131)	(0.070)	(0.134)
N	257030	257030	257030	256556	241833	257030	230790
log-likelihood	-206567.58	-211770.83	-209453.26	-208962.69	-197089.07	-210333.83	-190433.84
F	6.12***	11.54***	10.33***	12.65***	11.63***	8.99***	7.54***
Underidentification LM		346.06	320.48	316.45	298.49	313.68	283.03
Weak Instrument Test†		56.20	53.15	52.52	49.43	52.03	46.76
Hansen p-value		0.61	0.24	0.09	0.52	0.20	0.33
Municipality Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Industry Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Year Fixed Effects	✓	✓	✓	✓	✓	✓	✓
State X Year Fixed Effects			✓	✓	✓	✓	✓

*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$. *Source:* Own data collection and calculations. *Notes:* Economic promotion in one million. Eicker-White robust standard errors are in parentheses. †Kleibergen and Paap (2006) rank F-statistic for stationary data.

Table 4.10: Complete Poisson Models

	Dependent Variable: Number of Firm Foundations						
	Weighted Localization Index					Revenue Weighted Localization Index	
			Cut Pctl(90%)			Cut Pctl(90%)	
	Poisson	CF	CF	CF	CF	CF	CF
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Local Business Tax	-0.001***	-0.008***	-0.013***	-0.013***	-0.011***	-0.014***	-0.015***
	(0.000)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)
LOC X Local Business Tax	0.020	-0.241	4.931***	5.111***	5.172***	5.365***	5.404***
	(0.069)	(1.428)	(1.642)	(1.725)	(1.658)	(1.819)	(0.948)
Economic Promotion	0.003**	0.072**	0.099***			0.085**	
	(0.001)	(0.035)	(0.038)			(0.039)	
LOC X Economic Promotion	0.318***	4.088	-22.773***			- 24.233***	
	(0.082)	(5.369)	(5.598)			(6.450)	
Total Capital Stock				0.013*			0.008
				(0.007)			(0.006)
LOC X Total Capital Stock				-1.518***			-1.475***
				(0.396)			(0.192)
Expenditures					0.015**		
					(0.006)		
LOC X Expenditures					-3.892***		
					(0.960)		
Population in 1000	0.006**	0.010**	0.010**	-0.011	-0.001	0.009*	-0.004
	(0.003)	(0.005)	(0.004)	(0.011)	(0.005)	(0.005)	(0.010)
Unemployment Rate	0.023***	0.024***	0.023***	0.023***	0.017***	0.023***	0.023***
	(0.005)	(0.005)	(0.006)	(0.007)	(0.005)	(0.006)	(0.005)
Share Low Qualified Worker in %	0.012**	0.010	0.005	0.003	0.001	0.006	0.003
	(0.006)	(0.006)	(0.006)	(0.007)	(0.006)	(0.006)	(0.006)
Share Medium Qualified Worker in %	0.005	0.004	0.003	0.005	0.004	0.004	0.006
	(0.004)	(0.004)	(0.005)	(0.006)	(0.004)	(0.005)	(0.005)
Share High Qualified Worker in %	-0.008	-0.016	-0.027*	-0.019	-0.011	-0.024*	-0.016
	(0.012)	(0.012)	(0.015)	(0.015)	(0.011)	(0.012)	(0.012)
Students	0.002***	0.001	0.001	0.002**	0.001	0.001	0.002**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Doctors	0.002***	0.002***	0.002**	0.001*	0.001*	0.002***	0.002**
	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
N	2,866,802	2,866,802	2,577,383	2,577,383	2,577,087	2,575,829	2,575,829
Municipality Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Industry Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Year Fixed Effects	✓	✓	✓	✓	✓	✓	✓
State X Year Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Instrument Controls		✓	✓	✓	✓	✓	✓
Control Function Residuals		✓	✓	✓	✓	✓	✓
Bootstrapped SE		✓	✓	✓	✓	✓	✓
# of Bootstraps		50	50	50	50	50	50

$^*p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. *Source:* Own data collection and calculations. *Notes:* Economic promotion in one million. Bootstrapped and clustered standard errors are in parentheses.

Table 4.11: Complete Log-Linear Models with Varying Localization Distance from 5km to 30km.

	Dependent Variable: ln(Number of Firm Foundations)					
	Weighted Localization Index			Revenue Weighted Localization Index		
	5km (1)	10km (2)	30km (3)	5km (4)	10km (5)	30km (6)
ln(Local Business Tax)	-1.469**	-1.544**	-1.701***	-1.505**	-1.506**	-1.495**
	(0.607)	(0.609)	(0.612)	(0.609)	(0.610)	(0.610)
LOC X ln(Local Business Tax)	65.118*	53.640**	39.227***	49.089***	28.411***	12.175***
	(34.331)	(22.278)	(11.922)	(17.491)	(9.917)	(4.631)
ln(Economic Promotion)	0.205***	0.219***	0.265***	0.240***	0.247***	0.268***
	(0.072)	(0.073)	(0.074)	(0.073)	(0.073)	(0.074)
LOC X ln(Economic Promotion)	5.704***	0.793	-2.947***	-3.025***	-2.431***	-1.857***
	(1.744)	(1.161)	(0.639)	(0.948)	(0.544)	(0.258)
ln(Population in 1000)	-0.078	-0.078	-0.082	-0.067	-0.068	-0.073
	(0.079)	(0.080)	(0.082)	(0.080)	(0.080)	(0.080)
ln(Unemployment Rate)	-0.019	-0.018	-0.018	-0.019	-0.019	-0.020
	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)
Share of Low Skilled Workers in %	-0.014***	-0.014***	-0.015***	-0.014***	-0.015***	-0.015***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Share of Medium Skilled Workers in %	-0.003	-0.003	-0.004	-0.004	-0.004	-0.004
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Share of High Skilled Workers in %	-0.020***	-0.021***	-0.022***	-0.021***	-0.022***	-0.023***
	(0.006)	(0.006)	(0.007)	(0.006)	(0.007)	(0.007)
ln(Students)	0.000	0.000	0.000	0.000	0.000	0.000
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
ln(Doctors)	-0.024	-0.026	-0.030	-0.029	-0.029	-0.030
	(0.047)	(0.048)	(0.048)	(0.048)	(0.048)	(0.048)
Wind X Reform	-0.019	-0.019	-0.019	-0.018	-0.018	-0.019
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Wind X Reform X Trend	0.013***	0.012***	0.012***	0.012***	0.012***	0.012***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
LOC X Wind X Reform	0.848***	0.622***	0.409***	0.599***	0.347***	0.164***
	(0.212)	(0.136)	(0.071)	(0.109)	(0.062)	(0.029)
LOC X Wind X Reform X Trend	-0.490***	-0.276***	-0.112***	-0.154***	-0.073***	-0.018***
	(0.045)	(0.029)	(0.015)	(0.023)	(0.013)	(0.006)
N	229370	229370	229370	229370	229370	229370
log-likelihood	-187594.23	-188155.17	-189783.38	-188807.70	-189007.27	-189368.59
F	25.48***	14.07***	10.38***	7.44***	9.60***	26.24***
Weak Instrument Test†	48.71	48.86	49.15	48.03	48.01	47.96
Hansen p-value	0.55	0.52	0.46	0.32	0.36	0.48
Municipality Fixed Effects	✓	✓	✓	✓	✓	✓
Industry Fixed Effects	✓	✓	✓	✓	✓	✓
Year Fixed Effects	✓	✓	✓	✓	✓	✓
State X Year Fixed Effects	✓	✓	✓	✓	✓	✓

$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. *Source:* Own data collection and calculations. *Notes:* Economic promotion in one million. Eicker-White robust standard errors are in parentheses. †Kleibergen and Paap (2006) rank F-statistic for stationary data.

Table 4.12: Complete Poisson Models with Varying Localization Distance from 5km to 30km cut at the 90% Quantile

	Dependent Variable: Number of Firm Foundations					
	Weighted Localization Index			Revenue Weighted Localization Index		
	5km (1)	10km (2)	30km (3)	5km (4)	10km (5)	30km (6)
Local Business Tax	-0.014***	-0.015***	-0.011***	-0.014***	-0.015***	-0.011***
	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.004)
LOC X Local Business Tax	0.995***	0.732***	0.158	0.976***	0.651***	0.104
	(0.286)	(0.214)	(0.158)	(0.234)	(0.146)	(0.134)
Economic Promotion	0.100**	0.090**	0.079*	0.088***	0.083***	0.066*
	(0.048)	(0.040)	(0.044)	(0.031)	(0.031)	(0.034)
LOC X Economic Promotion	-4.581***	-3.311***	-0.887*	-4.365***	-2.881***	-0.611
	(0.998)	(0.662)	(0.501)	(0.889)	(0.569)	(0.383)
Population in 1000	0.010**	0.009**	0.009*	0.009**	0.008**	0.008**
	(0.005)	(0.004)	(0.005)	(0.004)	(0.004)	(0.004)
Unemployment Rate	0.024***	0.023***	0.023***	0.023***	0.023***	0.023***
	(0.006)	(0.006)	(0.005)	(0.006)	(0.006)	(0.005)
Share Low Skilled Workers	0.003	0.005	0.007	0.005	0.005	0.009
	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Share Medium Skilled Workers	0.003	0.004	0.003	0.004	0.004	0.005
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Share High Skilled Workers	-0.027**	-0.024	-0.017	-0.024*	-0.022*	-0.014
	(0.012)	(0.015)	(0.012)	(0.014)	(0.013)	(0.010)
Doctors	0.002***	0.002**	0.002***	0.002***	0.002***	0.002***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Students	0.001	0.001	0.001	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
N	2,507,724	2,577,383	2,512,080	2,505,564	2,505,564	2,579,973
Municipality Fixed Effects	✓	✓	✓	✓	✓	✓
Industry Fixed Effects	✓	✓	✓	✓	✓	✓
Year Fixed Effects	✓	✓	✓	✓	✓	✓
State X Year Fixed Effects	✓	✓	✓	✓	✓	✓
Instrument Controls	✓	✓	✓	✓	✓	✓
Control Function Residuals	✓	✓	✓	✓	✓	✓
Bootstrapped SE	✓	✓	✓	✓	✓	✓
# of Bootstraps	50	50	50	50	50	50

$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. *Source:* Own data collection and calculations. *Notes:* Economic promotion in one million. Bootstrapped and clustered standard errors are in parentheses.

Chapter 5

Do Political Parties Matter? - Evidence from German Municipalities

Nadine Riedel* Martin Simmler† Christian Wittrock‡

Abstract

The paper aims to test whether partisanship affects policy outcomes at the local level. While the literature has presented comprehensive evidence for partisan effects on policy outcomes at the state and federal level, recent findings suggest that partisan effects may be absent at the city and municipality level. Using detailed data on public inputs, goods and service spending, we assess the link between the partisanship of local councils as well as mayors and the composition of public good spending of German localities. We use three different estimation strategies to assess the link between partisan politics and public spending. First, we use a Regression Discontinuity Design framework of mayoral elections in Bavaria and North Rhine-Westphalia to determine the effects of close elections. Second, we estimate simple fixed effects regressions of various expenditure categories on partisan dummies. This procedure resembles a difference-in-differences approach to asses the relevance of left- or right-wing governed councils or mayors for expenditure compositions in German municipalities. We use Coarsened Exact Matching to reduce potential imbalances between our control and treatment group. Last, we investigate whether left- or right-wing governed municipalities differ in their response to exogenous revenue shocks during their legislative term (induced by changes of the personal income tax base assigned to municipalities). All three methods point to only mild partisan effects on the local level.

JEL Classification: H7, H4, R5
Keywords: partisan effects; local governments; public spending

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I. Introduction

Do political parties matter? A growing body of empirical research suggests that the answer to this question is ‘yes’, presenting evidence that political partisanship affects various policy outcomes, including per-capita spending, spending composition and tax choices (see e.g. Besley and Case 2003, Lee *et al.* 2004, Potrafke 2011a and Potrafke 2011b) and parties taking extreme positions to maximize votes (see e.g. Alesina 1988, Besley and Coate 1997 and Glaeser *et al.* 2005). Existing studies on partisan effects are, however, largely restricted to state and national governments and legislative bodies (see Imbeau *et al.* 2001, for an overview). In a recent paper, Ferreira and Gyourko (2009) present evidence suggesting that partisan effects are absent at the level of US cities. The authors assign their results to the fact that the local environment significantly differs from the national and state level, suggesting that, first, high levels of inter-jurisdictional mobility tend to create homogeneous local units (see Tiebout 1956), hence diminishing the role of partisanship; second, intensive competition of localities for locally mobile residents and capital may limit the scope for partisan politics and third, a smaller number of information channels for voters might prohibit politicians to communicate extreme positions. Additional studies on the local level are rare. Recently, Freier and Odendahl (2015) have shown that partisanship can influence tax rates in Bavaria.

Following Ferreira and Gyourko (2009) and Freier and Odendahl (2015), we empirically test for effects of political partisanship on the spending composition of German localities, which are the lowest government tier in Germany. We will focus on West Germany.[1] The analysis relies on comprehensive data on public spending of German municipalities between 1992 and 2006, allowing us to identify detailed spending categories, including (mandatory and non-mandatory) spending for e.g. child- and youth care, culture and infrastructure. The data is linked to information on local council elections and the party composition of the council as well as mayoral

[1]Data for East-Germany is available starting in 1998. Nevertheless, we restrict ourselves to West Germany because East-Germany can’t be treated as equal with the East-German sample period starting only eight years after reunification.

elections. As West Germany hosts around 8,500 municipalities, the data allows us to exploit rich variation in the partisanship of the local legislature. At the same time, German municipalities operate in a homogeneous institutional environment and have the same policy instruments at hand.

The empirical analysis is split into three main identification strategies. First, we exploit information on voter shares for local mayors to implement a Regression Discontinuity Design. Following Freier and Odendahl (2015) the identity of the mayor around the 50% threshold is as good as random. This allows us to identify changes in the expenditure composition (determined by non-mandatory spending in different categories, e.g. child- and youth care or infrastructure) in close elections.[2] To do so, we will define close mayoral elections as elections where the winning mayor had a victory margin of 2% (or 5%). To identify partisan differences we will only consider mayors of the two major parties 'SPD' and 'Union'. This parties can be separated as left- or right-wing parties (see Pappi and Eckstein 1998, for the location of German parties on a two dimensional scale). We find evidence that 'SPD' mayors spend more on youth expenditures and less on productive expenditures compared to all other mayors. However, the differences of expenditures shares in municipalities governed by 'SPD' or 'Union' are small. The second strategy aims to determine the effect of changes in the partisan composition of the local council or mayor on policy outcomes across localities. Specifically, we estimate fixed effects models and assess whether changes in the partisan composition of the local mayor or local council affects the spending pattern of German localities, conditional on a comprehensive set of socio-economic control variables for the locality. This approach allows us to compare the estimates for mayors with the RDD results and to augment findings with results using the partisan composition of the local council. To do so, we will consider municipalities with local councils dominated (more than 50% of the council seats) either by the 'SPD' or the 'Union' and compare it to municipalities with other dominant parties. To emphasize the difference-in-difference approach and to assess

[2]Freier (2015) uses a similar approach to estimate the incumbency effect in mayoral elections in Germany. He identifies a causal incumbency effect of 38-40 percentage points in the probability of winning the next election.

the robustness of our results, we moreover match municipalities using Coarsened Exact Matching. The matching procedure allows us to balance municipalities and helps to create comparable treatment and control groups to reduce estimation bias. The results point to mild partisan effects among left- or right-wing governed municipalities. Lastly, we investigate whether 'SPD' or ' Union' councils or mayors differ in their spending response to exogenous income shocks, i.e. we assess whether one additional Euro of revenues is spent differently in left- or right-wing municipalities. Exogenous revenue shocks are modeled using an instrumental variable approach.

The rest of the article is structured as follows. Section II describes the institutional background and data. The empirical analysis is presented in sections IV to V. Section VI concludes.

II. Institutional Background and Data

The empirical analysis to come will assess partisan effects using the spending composition and level of West German localities as a testing ground. In the following, we describe the institutional background and the data set used for the empirical analysis.

A. Institutional Background

According to the German constitution, German municipalities have elected legislative bodies and governments and have the right to solve any local matters autonomously (Article 28 of the German constitution). Localities generate income from two main sources. Firstly, a fraction of the personal income tax and the value added tax revenue administered at the federal and state level are distributed to German municipalities based on fiscal rules. Municipalities may also receive special grants by higher government tiers. Secondly and importantly, localities have two (major) own revenue instruments at hand: firstly, they can autonomously set the local business tax rate, levied on business income earned within their borders and secondly, they choose the local property tax.[3] The majority of tax revenues from these two sources remains with the locality. Only a minor fraction is redistributed by fiscal equalization schemes.[4] Note that the own tax revenue instruments generate a significant fraction of local income (on average about 20% in 2006).[5]

German municipalities moreover provide various local public inputs, goods and services (PIGS), e.g. related to the construction and maintenance of roads, sewerage, kindergartens and primary schools. Further, municipalities have to provide social benefits to the unemployed and social welfare recipients. Additionally, public goods and services related to culture and sport facilities, tourism, and public transport may be provided. Note that while some expenditures are mandatory, including administration, social security and financing liabilities, others are optional, including e.g. spending for theaters, youth centers, the promotion of science, health care, sport and recreation facilities. As sketched in the introduction, the empirical analysis to come will investigate whether *voluntary* spending of localities is affected by the partisanship of the local council (which is the legislative body that, with a majority vote, decides on the local budget and hence on the localities' revenue and spending policies) or local mayor.

B. Data

Our analysis relies on rich data for PIGS spending of German localities between 1992 and 2006. Namely, we draw on municipalities' accounting information provided in the *Jahresrechnungsstatistik* that allows us to construct spending items for detailed and disaggregated expenditure categories. Since we are interested in the effect of partisanship on local spending, we restrict our view to spending items that localities can plausibly affect, i.e. we disregard mandatory spending, for example

[3]Note that Germany localities set two property taxes (A and B). Property Tax A is applied on land used for agricultural and forestry. Property Tax B is used for any other build-up property.
[4]Municipalities may also levy other minor local taxes (e.g. a 'dog tax').
[5]Calculations are based on our sample.

social expenditures for the unemployed or social welfare recipients.[6]

In what follows we will concentrate on the share of PIGS expenditures relative to overall expenditures in six categories: 1) administration and public security (*Administration*), 2) child- and youth care as well as public schools (*Youth*), 3) culture and public education (*Culture*), 4) recreation and sports (*Leisure*), 5) infrastructure and economic promotion (*Productive*), 6) debt repayment (*Debt*). We augment the regressions by a residual category (*Other*).[7] *Administration* captures all administration and public safety (e.g. fire and rescue or public security) expenditures of German municipalities. They serve as a proxy for the size of the local government. Expenditures for *Youth* e.g. includes child care places or youth centers as well as maintenance of public school facilities. *Culture* and *Leisure* include expenditures for e.g. theaters, museums, public parks or swimming pools. Expenditures for *Productive* goods include spending for infrastructure (e.g. local streets or parking facilities) or economic promotion. [8] Expenditures will be expressed in shares of overall expenditures. Descriptive statistics are presented in Table 5.1 and show that overall spending per capita and the share of PIGS spending varies significantly across localities. Additionally, Table 5.1 depicts descriptive statistics of income tax revenues. The latter will be used to assess the effect of exogenous revenue shocks and whether parties spend an additional Euro differently. An average municipality in our sample has approximately $7,160$ inhabitants and spends 1858 Euro per Capita. The highest share among our *voluntary* categories are expenditures for *Youth* with (on average)

[6]To control for changes of this expenditures we include a residual category and overall expenditures in the regressions.

[7]The residual category is the difference of overall expenditures and the five considered expenditure categories.

[8]Specifically, the spending items (for staff expenditures, maintenance, asset acquisition, construction, investments) comprise the following subcategories: (1) *Administration* a) administration expenditures b) fire and rescue c) public security; (2) *Youth* a) institutions for social assistance and welfare benefits for war victims b) youth welfare c) institutions for youth work, youth residents, pupil residents and trainee residents d) mother support e) daycare for children f) youth and family counseling g) institutions for the education of young adults h) education of public employees i) construction and maintenance of primary and higher education schools; (3) *Culture* a) museums, exhibitions and collections b) theaters, concerts, music c) other arts d) public education e) fostering of regional values and tradition; (4) *Leisure* a) sports promotion b) own sports facilities c) public swimming d) public parks and e) other recreational facilities; (5) *Productive* a) municipality streets, b) county streets, c) street lighting and cleaning d) parking e) economic promotion.

7.55% and *Productive* with (on average) 6.71% of overall expenditures.[9]

Table 5.1: Descriptive Statistics

	Mean	Median	Std. Dev.
Share Administration in %	9.50	9.37	3.87
Share Youth in %	7.55	6.84	5.07
Share Culture in in %	0.62	0.28	1.04
Share Leisure in %	2.08	1.33	2.86
Share Productive in %	6.71	5.38	4.95
Share Debt in %	3.51	2.39	3.91
Share Other in %	70.02	70.54	8.42
Overall Expenditures per Capita	1857.75	1749.45	618.93
Population in 1000	7.16	3.14	10.59
Average Population in 1000 within 30km	9.19	5.72	12.10
Employed Population in 1000	2.29	1.06	3.27
Share Population under 20 in % (County)	21.82	21.86	1.37
Share Population over 65 in % (County)	19.36	19.17	1.79
Debt per Capita (County)	941.62	892.25	354.74
Unemployment Rate (County)	8.19	7.80	2.42
Overall Revenue per Capita	1809.52	1689.91	618.89
Income Tax Revenue per Capita	290.83	282.96	77.54
Observations	3121		

Source: Own data collection and calculations. *Notes:* Calculations are based on a sample with dominated councils for 3121 municipalities and the year 2006.

Table 5.2: Elections for the Local Council and Majors by Federal State and Year (1996 to 2006)

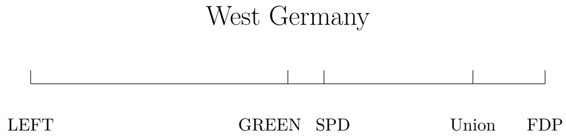
	Year										
State	96	97	98	99	00	01	02	03	04	05	06
SH			✓					✓			
NI	✓					✓					✓
NRW				✓					✓		
HE		✓				✓					✓
RP				✓					✓		
BW				✓					✓		
BY	✓						✓				
SL				✓					✓		

Source: Own data collection. The checkmarks represent local council elections in the data. We do have information about the mayor elections for the highlighted federal states. Federal States: SH) Schleswig-Holstein NI) Lower Saxony NRW) North Rhine-Westphalia HE) Hessia RP) Rhineland-Palatine BW) Baden-Wuerttemberg BY) Bavaria SL) Saarland. We also have information on the received voter share in mayoral elections for NRW and BY.

The data on public spending is linked to information on the party composition of the local council obtained from the German Federal Statistical Offices and hand collected data on party affiliations of local mayors. German politics on the state and national level is dominated by five parties: the conservative Christian Democratic Union (CDU), the liberal party of the Free Democratic Party (FDP), the leading left-wing Social Democratic Party (SPD), the Greens (B90/Grüne) and the far-left

[9]We drop so called ‘Kreisfreie Städte’ from the analysis. These cities have a special institutional setting and cannot be treated as equivalent to municipalities in our sample.

Figure 5.1: One dimensional axis of party position by Pappi and Eckstein (1998)



party 'Die Linke'.[10] We follow prior research to classify parties on a left- and right-wing scale. Left- and right-wing is determined by the position of a political party on a one dimensional axis (see Figure 5.1) following Pappi and Eckstein (1998). Our analysis will exploit the difference of the political position of the two main political parties 'SPD' and 'Union'.[11] Note that German politics at the local level is characterized by the presence of a large number of civil parties that may play a quite prominent role in local politics (partly related to the absence of minimum vote share requirements to enter the local council). These civil parties are difficult to classify on a left-right-scale and are subsumed in a residual category.[12] We do not observe information about coalitions on the local level. Table (5.2) lists the available council elections in our data which vary over time and federal states.

Our analysis will classify local councils to be dominated by the 'SPD' or 'Union' if the respective groups hold more than 50% of the council seats.[13] While there is a significant number of localities with a 'SPD' or 'Union' majority, many municipalities have councils with no or undefined political dominance. Following the literature, partisan politics is more likely to occur between dominated councils. Hence, we drop municipalities where no party holds the majority of council seats. Our data also includes information about party affiliation of local mayors in four federal states (North Rhine-Westphalia, Hessia, Rhineland-Palatine and Bavaria). Head of the

[10] In Bavaria the CDU is represented by its sister party the CSU. We refer to both as Union.

[11] To control for the robustness of our results we define 'SPD', 'B90/Grüne' and 'Die Linke' as left wing parties and 'Union' as well as 'FDP' as right wing parties and reestimate our identification strategy. Results for the robustness check are reported in Appendix B. Following Pappi and Eckstein (1998) the political position of the left party 'Die Linke' is different from 'SPD' and 'B90/Grüne'. Including or excluding it from our definition of left-wing parties does not alter results as the party was present in only 63 local councils in our sample with an average seat share of 3%.

[12] Civil parties can't be classified into a traditional system as parties and programs vary between localities.

[13] Note that the data does not allow us to identify actual coalitions within local councils. Hence, we assume that if a left- or right-wing party group holds at least 50% of the seat shares that they form a coalition - which matches with anecdotal evidence.

local administration is the mayor. In small localities mayors have extensive power, and thus may be the main driver of partisan politics. We can test this implication and compare it with the results for local councils. On top, we posses information on the votes a mayor received.[14] This allows us to calculate the victory margin for each election.

We furthermore add control variables for socio-economic municipality characteristics, including information on population, employment, age groups, the unemployment rate, debt on the county level and municipalities overall revenue.

III. Regression Discontinuity Design

In a first step we use mayoral elections in Bavaria and North-Rhine Westphalia to implement a Regression Discontinuity Design (RDD) to test if mayors who won in close elections use their power to implement partisan policies (see Freier and Odendahl 2015 and Freier 2015 for a similar approach).[15] We use two definitions for close elections. First, we define close election as elections in which the share of votes received by the winning mayor does not exceed the share of votes of the second placed candidate by 2%. Second, we increase this threshold to 5%.

Table (5.3) depicts the results for Bavaria and North Rhine-Westphalia where the winning mayor was either a candidate of the 'SPD' (specifications (1) and (2)) or the 'Union' (specifications (3) and (4)) using mean expenditure shares over the election period. If an 'SPD' mayor won in a close election we identify a significant and positive point estimates on the share of *Administration* expenditures of 1.45% and *Youth* expenditures ranging from 3.07% to 1.84%. On top, we identify a positive and significant point estimate on the share for *Culture* expenditures ranging from 0.66% to 0.4%. Moreover, we identify a negative and significant point estimate for infrastructure and economic promotion spending ranging from 2.44% to 1.40%. For

[14]This information is only available for Bavaria and North Rhine-Westphalia.

[15]Note that we are restricted to Bavaria and North-Rhine Westphalia as these are the only states that provide information on the votes each candidate received in an election.

Table 5.3: Mayor RDD

	SPD		Union	
	(1)	(2)	(3)	(4)
Victory Margin	2%	5%	2%	5%
(A) Administration	1.45*	0.52	0.73	-0.03
	(0.82)	(0.51)	(0.59)	(0.38)
(B) Youth	3.07***	1.84***	-0.22	0.47
	(0.89)	(0.64)	(0.82)	(0.51)
(B) Culture	0.66***	0.40***	-0.16	-0.21*
	(0.22)	(0.15)	(0.19)	(0.12)
(C) Leisure	0.09	0.40	0.08	-0.07
	(0.36)	(0.25)	(0.28)	(0.20)
(D) Productive	-2.44***	-1.40***	-0.43	-0.71
	(0.82)	(0.51)	(0.66)	(0.43)
(E) Debt	-0.85	-0.27	-0.27	-0.17
	(0.52)	(0.34)	(0.41)	(0.26)
(F) Other	-2.03*	-0.72	1.54	1.45*
	(1.17)	(0.89)	(1.16)	(0.84)
Observations	55	133	96	252

Significance levels: * < 0.10, ** < 0.05, *** < 0.01. *Source:* Own data collection and calculations. *Notes:* Robust standard errors are in parentheses.

the sample of 'Union' mayors that won in a close election with a victory margin of 2% we identify no significant point estimates. We find evidence in favor of a decrease in the share of *Culture* expenditures for a victory margin of 5%. Moreover, the point estimates depict a higher share of expenditures for other goods compared to the sample of 'SPD' mayors. Summarizing, using an RDD approach we do find results in favor of higher *Youth* and *Culture* expenditures and lower *Productive* expenditures of 'SPD' mayors. Hence, we are able to identify significant differences between municipalities governed by 'SPD' mayors who won in a close election compared to all other mayors. However, the overall size of the effects is small.[16] Therefore, the RDD results point to mild partisan politics at best.

IV. Partisan Effects on Localities' Spending Composition

In a second step, we assess the impact of party composition of local councils on expenditures for different PIGS categories. To compare the results with the previous section we additionally analyze the party affiliation of local mayors. Moreover, to increase comparability we estimate our modeling strategy on the full sample as well

[16]Note that the sample size of municipalities with a close election are small and standard errors might be misleading.

as a subset of our sample comprising only Bavaria and North Rhine-Westphalia.

A. Empirical Strategy

The modeling strategy reads

$$y_{it} = \alpha_1 P_{it} + \alpha_2 \mathbf{X}_{it} + \lambda_i + \kappa_t + \varepsilon_{it}. \tag{5.1}$$

where P_{it} is a dummy indicating if the 'SPD' or 'Union' hold the majority in the local council or if the municipality is governed by a 'SPD' or 'Union' mayor. A significant point estimate α_1 would imply that the expenditure share y_{it} in a locality with a left-wing (right-wing) majority in the local council (or mayor) significantly differs from that of right-wing (left-wing) majorities (or mayors). The model accounts for municipality fixed effects λ_i and year fixed effects κ_t absorbing time constant heterogeneity across localities and common shocks to municipality spending in given categories over time. The approach consequently resembles a difference-in-difference analysis, comparing adjustments in the spending of localities with changing majorities in the course of elections to localities where majorities remained constant. Note in this context that local council elections vary across German states (see Foremny and Riedel 2014, for details). The vector $\mathbf{X}_{it}$ moreover comprises socio-economic control variables for our sample jurisdictions, including the natural logarithm of the localities' population (in 1000), (log) population in 30km radius, (log) employed population, age composition of the county as determined by the population shares aged under 20 and above 65, the (log) unemployment rate, (log) municipalities debt (both on the county level) and the localities' (log) overall revenue. Standard errors are robust using clustering on the municipality level.

B. Coarsened Exact Matching

To produce unbiased estimates the control and treatment group have to be identical before treatment (the election). Note however that this is rarely the case in observational data. Using matching methods we can prune observations from the data so that the empirical distribution of covariates in the treatment and control groups are more similar (Iacus *et al.* 2012). Commonly used is the propensity score (represented by the likelihood of being treated) to match observations, e.g. to find the closest control unit for every treatment observation, or to weight observations to create balance between control and treatment units (see Imbens 2004, for ar review). Using the propensity score to calculate treatment effects assumes that the correct propensity score model has been defined. In our sample treatment is defined as having a 'SPD' ('Union') majority or electing a 'SPD' ('Union') mayor (within our sample period), such that specifying the correct propensity score model is impractical. Furthermore, balancing the mean by using the propensity score can increase imbalance, inefficiency, model dependence and bias (King and Nielsen 2016). Therefore, we apply coarsened exact matching (CEM) introduced by Iacus *et al.* (2012) to balance left-wing and right-wing governed municipalities. CEM is less restrictive to reduce imbalance between covariates and can be easily used in post matching estimations. In a nutshell, CEM creates groups for each matching variable and defines matches based on this coarsened groups. As matching variables we will use pre-sample (log) population (in 1000) and (log) employed population, (log) overall expenditures and revenues, the number of higher education schools as well as the share of expenditures for voluntary categories.[17] Additionally, we match on the federal state of the locality. To apply CEM one has to choose meaningful groups for the matching variables. We rely on algorithms used to construct histograms (e.g. Sturge's rule) to automatically find meaningful groups. CEM assigns a set of strata $s \in S$ to each coarsened values $\mathbf{X}$. Subsequent, weights are used to decrease imbalance between observations. Each unit receives weight

[17] The number of higher education schools is based on hand collected data and is used as a proxy for the provision of schooling facilities as well as agglomeration economies within municipalities.

$$w_i = \begin{cases} 1 & \text{if } i \in T^s \\ \frac{m_C}{m_T}\frac{m_T^s}{m_C^s} & \text{if } i \in C^s \end{cases} \tag{5.2}$$

with T^s the treated units and C^s the control units in stratum s. The number of treated units in the stratum is denoted by m_T^s and the number of control units by m_C^s. The variables m_C and m_T represent the overall number of matched units. All unmatched units receive weight 0 (see Iacus *et al.* 2012, for more details). An advantage of the CEM approach is that matching is performed on the full distribution of covariates and not only on means. Using CEM we can reduce the overall imbalance measure from 81% to 50% for the sample with 'SPD' or 62% to 50% for the sample with 'Union' majorities in the local council. The overall imbalance for 'SPD' mayors is reduced from 69% to 63% and for 'Union' mayors from 63% to 54%.[18] Hence, in the 'SPD' sample without matching approximately only 19% (local councils) or 31% (mayors) of the multidimensional histograms overlap, while this increases to 50% and 37%. Due to our restriction to find groups within federal states matching is not perfect and imbalance remains. The CEM algorithm bounds the imbalance from above by using weights in follow-up regressions. On top, the algorithm allows to control for the remaining imbalance in follow-up regressions by including matching variables as controls.

C. *Empirical Results*

Table (5.4) presents the results of estimating equation (5.1) in a coarsened sample.[19] Specifications (1) to (4) use the subsample of Bavaria and North Rhine-Westphalia and specifications (5) to (8) the full sample. Rows (A) to (G) depict the relevant category (dependent variable). The point estimates represent the effects of our

[18] The imbalance measure introduced by Iacus *et al.* (2012) lies between 0% (perfect balance) and 100% (complete separation). Any value in the interval (0%,100%) indicates the amount of difference between k-dimensional frequencies of the two groups.

[19] Results are robust to taking the average over the election periods.

partisan dummies (either 'SPD' or 'Union' majority in the local council or mayor) on the dependent variables. Overall, we find only mild evidence for the existence of partisan politics on the local level.

Table 5.4: Linear regression of expenditure shares on majorities in the local council or mayors in a coarsened sample

	Dep. Var.: Expenditure Shares							
	Bavaria & NRW				West Germany			
	Mayor		Council		Mayor		Council	
	SPD (1)	Union (2)	SPD (3)	Union (4)	SPD (5)	Union (6)	SPD (7)	Union (8)
(A) Administration	0.38**	-0.28**	0.32	-0.06	0.38***	-0.31***	0.26*	-0.12
	(0.16)	(0.14)	(0.53)	(0.27)	(0.11)	(0.11)	(0.15)	(0.15)
(B) Youth	0.17	0.04	-1.29	0.25	0.22	-0.14	0.56**	0.08
	(0.24)	(0.20)	(0.86)	(0.30)	(0.20)	(0.16)	(0.28)	(0.24)
(C) Culture	0.07	-0.09	-0.03	-0.04	0.10*	-0.08	-0.06	-0.01
	(0.10)	(0.08)	(0.18)	(0.05)	(0.06)	(0.06)	(0.06)	(0.04)
(D) Leisure	0.09	0.05	0.12	-0.07	0.12	0.08	0.38**	-0.19
	(0.21)	(0.13)	(0.27)	(0.10)	(0.14)	(0.10)	(0.19)	(0.12)
(E) Productive	-0.28	-0.10	-0.20	0.47	-0.39*	0.17	0.16	0.20
	(0.34)	(0.24)	(0.94)	(0.36)	(0.23)	(0.20)	(0.36)	(0.24)
(F) Debt	0.38	-0.16	-0.32	-0.03	0.13	-0.23	-0.15	-0.20
	(0.24)	(0.21)	(0.66)	(0.36)	(0.14)	(0.16)	(0.20)	(0.23)
(G) Other	-0.80*	0.55	1.39	-0.52	-0.56*	0.51*	-1.17**	0.23
	(0.47)	(0.36)	(1.41)	(0.65)	(0.33)	(0.29)	(0.50)	(0.41)
Observations	9853	12420	1161	7675	15973	18119	9419	20246
Year Fixed Effects	✓	✓	✓	✓	✓	✓	✓	✓
Municipality Fixed Effects	✓	✓	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓	✓	✓

Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. *Source:* Own data collection and calculations. *Notes:* Municipality clustered robust standard errors are in parentheses. For full estimation tables see Appendix C.

Using the subsample for Bavaria and North Rhine-Westphalia and local mayors we find point estimates in favor of a 0.38% higher share of *Administration* expenditures by 'SPD' mayors and 0.28% lower share by 'Union' mayors. We do identify similar point estimates in a sample with all federal states (with information on mayoral elections). On top, using council information in West Germany we find evidence in favor of a higher share of *Administration* expenditures by 'SPD' dominated councils. Hence, if administration expenditures are a proxy for the size of the local government we find evidence for mildly bigger governments if the locality is governed by a left-wing party.

Using all mayoral elections in Bavaria and North Rhine-Westphalia does not give significant point estimates for *Youth*, *Culture* and *Productive* expenditure shares as in the RDD estimation. Nonetheless, we identify a positive point estimate for the former two and a negative point estimate of the latter providing weak evidence in favor of our RDD results. On top, using all mayoral election in our sample we identify a 0.1% higher share of *Cultural* expenditures and a 0.39% lower share of *Productive* expenditures supporting the RDD results. Moreover, if the municipality is governed by the 'SPD' we find a 0.56% lower share for *Other* expenditures.

Using council elections in Bavaria and North Rhine-Westphalia does not produce significant point estimates. However, using the full sample we identify a significant and positive point estimate on the share of *Youth* expenditures of 0.56 and *Leisure* expenditures of 0.38 as well as a significant and negative point estimate on the share of *Other* expenditures of 1.17.

Summarizing, doing simple fixed effects regression we are able to identify only few significant effects of partisanship on expenditure shares. Comparable to the Regression Discontinuity Design we identify point estimates in favor of a higher share of *Youth* and *Cultural* expenditures as well as a lower share of *Productive* expenditures if the locality is governed by a 'SPD' mayor or the 'SPD' holds the majority in the local council.[20] However, although some difference between left- and right-wing governed municipalities exist, these difference tend to be small using expenditure shares providing evidence for mild partisan effects at best.

V. Partisan Effects on Spending Responses to Exogenous Revenue Shocks

Sections III and IV show that municipality expenditures are adjusted after elections and point to evidence for mild partisan politics on the local level. The following section contributes to the previous results by analyzing the responses to exogenous revenue shocks i.e. whether parties spend an additional (unanticipated) Euro of income differently. To address obvious endogeneity concerns, we run instrumental variable approaches where exogenous revenue shocks of income tax revenues on local

[20]Using left- and right-wing majorities including the 'Greens', the 'FDP' and the far left party does support our results for *Youth* expenditures (see Table (5.9) in Appendix A).

budgets are modeled by an instrumental variable (which will be described in detail below). Furthermore, as presented in section IV we use coarsened exact matching to identify municipalities with right- or left-wing dominated local councils that are comparable in observable characteristics to reduce the bias of our estimates. In contrast to the previous performed matching we additionally match on the logarithmic level of (log) income tax revenues.

A. Empirical Strategy

Specifically, we estimate a model of the following form

First Stage:

$$R_{it} = \gamma_1 Z_{it} + \gamma_2 Z_{it} \times P_{it} + \gamma_3 \mathbf{X}_{it} + \lambda_i + \kappa_t + \nu_{it} \tag{5.3}$$

$$R_{it} \times P_{it} = \delta_1 Z_{it} + \delta_2 Z_{it} \times P_{it} + \delta_3 \mathbf{X}_{it} + \lambda_i + \kappa_t + \mu_{it} \tag{5.4}$$

Second Stage:

$$y_{it} = \beta_1 \widehat{R_{it}} + \beta_2 \widehat{R_{it} \times P}_{it} + \beta_3 P_{it} + \beta_4 \mathbf{X}_{it} + \lambda_i + \kappa_t + \varepsilon_{it}. \tag{5.5}$$

where $y_{i,t}$ depicts expenditures in a given spending category and R_{it} the instrumented income tax revenue of municipality i in year t. P_{it} is a dummy taking the value one if left-wing (right-wing) parties hold the majority in the local council or if the municipality is governed by a left-wing (right-wing) mayor. Revenues and the interaction term are instrumented using an instrument Z_{it}. The predicted values $\widehat{R_{it}}$ and $\widehat{R_{it} \times P}_{it}$ are then used in the second stage. The coefficient estimate β_2 for the interaction between the majority indicator P_{it} and municipality revenues $\widehat{R_{it}}$ captures differences in spending responses to income shocks by left-wing (right-wing) majorities/mayors in localities relative to right-wing (left-wing) and other majorities/mayors. Note that the estimation model again controls for municipality λ_i and year κ_t fixed effects as well as socio-economic control variables $\mathbf{X}_{it}$. The equations are estimated using two-stage-least squares with clustered standard errors on the municipality level.

B. Instrument for Municipality Revenues

We will model exogenous shocks to local governments' income tax revenue using an instrument that draws on the fact that German personal income tax revenues are collected on the federal state level and distributed to the federal, state, and municipality levels according to a predetermined key. Precisely, the shares assigned to each government level are fixed by law. Municipalities receive 15% of the tax revenue (42.5% Länder and 42.5% state). The precise share assigned to each municipality is calculated based upon a tax key that changes every 3 years and is based on previous collected income tax revenues (five years ago). In general the tax key is calculated by taking the share of personal income tax revenues collected in one municipality divided by the share of personal income tax revenues collected in the federal state.[21] In our sample period the tax key changed four times (in 1997, 2000, 2003 and 2006). Hence, the share of the personal income tax that a municipality received was fixed in-between these time periods and only varies based on the overall collected income tax revenue in the federal state. The exact change of the tax key is previously unknown for the local government. We assume that municipalities form expectations about the amount they will receive by multiplying the tax revenue collected by the federal state with last years tax key. We subtract the expected amount from the actual received revenue to generate the deviation. To exclude potential anticipation of the deviation due to changes in the population we regress the deviation on (lagged) population and (lagged) population squared (up to four lags) and use the error of this regression as our instrument.[22] The error is uncorrelated with the dependent variable (by construction) and hence fulfills the orthogonality condition for excluded instruments.[23]

[21] The calculation of the tax key assumes a maximum amount of taxable income per person. Hence, the tax revenues that are used when calculating the distribution key are always smaller or equal than the collected tax revenues.

[22] We include municipality, year and state times year fixed effects. To use the logarithm of the dependent variable we add the mean income tax revenue over our sample period.

[23] The calculation of our instrument emulates the idea of a recent contribution to the economic literature by Serrato and Wingender (2016).

C. Empirical Results with Instrumented Revenue Shocks

Tables (5.5) to (5.8) present estimations of equation (5.5) with 'SPD' ('Union') majorities in the local council or 'SPD' ('Union') mayors using the full set of federal states.[24] The first stage estimation results for majorities in the local council are presented in Table (5.10) in Appendix B. The point estimates show the expected signs and the instrument passes the Kleibergen and Paap (2006) rank F-Statistic for weak instruments. Point estimates of the second stage depict scarce evidence in favor of partisan politics on the local level with respect to unanticipated revenue shocks. We do not identify significant point estimates of (instrumented) income tax revenues on PIGS expenditure shares for 'SPD' and 'Union' mayors (see Tables (5.5) and (5.6)).

Table 5.5: Linear regression of expenditure shares on 'SPD' mayors in an instrumented and coarsened sample

	Mayor						
	(1) Administration b/se	(2) Youth b/se	(3) Culture b/se	(4) Leisure b/se	(5) Productive b/se	(6) Debt b/se	(7) Other b/se
(ln) Income Tax Revenue	-1.78	1.03	0.68	-0.36	1.30	-0.20	-0.68
	(1.08)	(1.58)	(0.55)	(1.01)	(2.58)	(1.82)	(3.19)
(ln) Income Tax Revenue X SPD	-0.48	0.46	-0.41	1.78	-0.33	-0.29	-0.72
	(1.42)	(1.85)	(0.59)	(1.29)	(2.85)	(2.21)	(3.59)
SPD	7.28	-6.12	5.86	-24.74	4.10	4.16	9.46
	(19.89)	(25.84)	(8.19)	(17.99)	(39.84)	(30.86)	(50.12)
N	15441	15441	15441	15441	15441	15441	15441
F Statistic	6.77***	3.99***	1.98***	2.59***	7.94***	3.08***	6.90***
Weak Instrument Test†	111.89	111.89	111.89	111.89	111.89	111.89	111.89
Year Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Municipality Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓	✓

Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. *Source:* Own data collection and calculations. *Notes:* Municipality clustered robust standard errors are in parentheses. †Kleibergen and Paap (2006) rank F-statistic for stationary data.

Results for local councils differ to a small extend. For a sample comparing municipalities with a 'SPD' dominated council with all other municipalities that had a dominated council, we find evidence in favor of a 6.11% decrease in the share of *Administration* expenditures and a 9.44% increase in the share of *Other* expenditures if municipality councils where not dominated by the 'SPD' and (instrumented) income tax revenues increased by 1%. Point estimates for 'SPD' dominated councils show opposite signs and are insignificant. Moreover, the linear combination of the point estimates for 'SPD' dominated councils and all other dominated councils are

[24] Note that our instrument is based on variation within multiple federal states. Therefore, using the instrument in a sample comprising of only Bavaria and North Rhine-Westphalia is not possible as the instrument strength is insufficient.

Table 5.6: Linear regression of expenditure shares on 'Union' mayors in an instrumented and coarsened sample

	Mayor						
	(1) Administration b/se	(2) Youth b/se	(3) Culture b/se	(4) Leisure b/se	(5) Productive b/se	(6) Debt b/se	(7) Other b/se
(ln) Income Tax Revenue	-1.37	-0.74	0.18	0.43	2.09	3.34	-3.94
	(1.00)	(1.55)	(0.32)	(0.82)	(1.66)	(2.46)	(2.51)
(ln) Income Tax Revenue X Union	-0.11	1.54	-0.15	1.74	-2.70	-1.37	1.05
	(1.60)	(2.50)	(0.53)	(1.69)	(2.98)	(3.17)	(4.15)
Union	1.24	-21.33	1.93	-23.84	37.23	18.67	-13.89
	(21.94)	(34.39)	(7.30)	(23.29)	(40.98)	(43.61)	(57.06)
N	17603	17603	17603	17603	17603	17603	17603
F Statistic	5.46***	4.96***	2.20***	2.44***	14.96***	4.21***	9.42***
Weak Instrument Test†	114.37	114.37	114.37	114.37	114.37	114.37	114.37
Year Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Municipality Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓	✓

Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. *Source:* Own data collection and calculations. *Notes:* Municipality clustered robust standard errors are in parentheses. †Kleibergen and Paap (2006) rank F-statistic for stationary data.

Table 5.7: Linear regression of expenditure shares on 'SPD' majority in the local council in an instrumented and coarsened sample

	Local Council						
	(1) Administration b/se	(2) Youth b/se	(3) Culture b/se	(4) Leisure b/se	(5) Productive b/se	(6) Debt b/se	(7) Other b/se
(ln) Income Tax Revenue	-6.11**	-3.98	-0.06	0.68	-0.84	0.87	9.44*
	(2.61)	(3.00)	(0.23)	(0.90)	(2.30)	(1.79)	(5.69)
(ln) Income Tax Revenue X SPD	5.04	-1.34	-0.23	-1.95	-1.63	1.28	-1.18
	(3.11)	(4.00)	(0.54)	(1.71)	(3.39)	(3.24)	(6.83)
SPD	-69.64	19.11	3.10	27.47	22.62	-18.02	15.37
	(43.19)	(55.62)	(7.52)	(23.83)	(47.07)	(45.03)	(94.88)
N	8932	8932	8932	8932	8932	8932	8932
F Statistic	5.80***	5.72***	0.85	1.73**	4.47***	3.45***	3.32***
Weak Instrument Test†	28.15	28.15	28.15	28.15	28.15	28.15	28.15
Year Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Municipality Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓	✓

Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. *Source:* Own data collection and calculations. *Notes:* Municipality clustered robust standard errors are in parentheses. †Kleibergen and Paap (2006) rank F-statistic for stationary data.

Table 5.8: Linear regression of expenditure shares on 'Union' majority in the local council in an instrumented and coarsened sample

	Local Council						
	(1) Administration b/se	(2) Youth b/se	(3) Culture b/se	(4) Leisure b/se	(5) Productive b/se	(6) Debt b/se	(7) Other b/se
(ln) Income Tax Revenue	0.51	2.75	-0.29	-0.55	2.12	1.04	-5.58
	(0.94)	(2.34)	(0.20)	(0.79)	(2.08)	(1.27)	(3.94)
(ln) Income Tax Revenue X Union	-4.39**	-1.64	0.22	2.12	-7.16**	-0.90	11.75**
	(2.16)	(3.19)	(0.36)	(1.52)	(2.87)	(1.86)	(5.49)
Union	62.43**	23.56	-3.11	-30.48	102.55**	12.69	-167.66**
	(30.86)	(45.60)	(5.18)	(21.64)	(40.92)	(26.53)	(78.44)
N	19398	19398	19398	19398	19398	19398	19398
F Statistic	8.19***	4.35***	2.44***	1.66**	8.24***	4.74***	4.49***
Weak Instrument Test†	56.15	56.15	56.15	56.15	56.15	56.15	56.15
Year Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Municipality Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓	✓

Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. *Source:* Own data collection and calculations. *Notes:* Municipality clustered robust standard errors are in parentheses. †Kleibergen and Paap (2006) rank F-statistic for stationary data.

insignificant. Thus, we can conclude that the share of *Administration* and *Other* expenditures are less sensitive to additional income tax revenues for 'SPD' governed municipalities. This results are in line with the previous findings. Comparing 'Union' dominated councils with all other dominated councils give similar results. We identify a decrease in the share of *Administration* and *Productive* expenditures and an increase in the share of *Other* expenditures if the council is dominated by the 'Union' and (instrumented) income tax revenues increase by 1%.

Overall, the results point to no or only mild partisan politics in terms of the share of *Administration*, *Productive* and *Other* expenditures.[25] Hence, using an instrumental variable approach to assess reactions of parties to an unexpected revenue shock we are not able to identify large partisan politics on the local level. These results contribute to the previous sections. Using simple fixed effects estimation or RDD we were able to identify only mild differences (in expenditure shares) between municipalities that are governed by opposing parties. While this results might be explained by higher inter-jurisdictional mobility, intensive competition between localities or a lack of information channels (Ferreira and Gyourko 2009) we would expect that unexpected revenues enable parties to engage in partisan politics. However, we do not find strong evidence to support this hypothesis.

VI. Conclusion

The aim of this paper was to assess the role of partisanship within West German local councils on spending for public goods, inputs and services. In doing so the paper adds to a flourishing empirical literature on the identification of partisan effects. Existing studies are, however, largely restricted to the state and national government level (see e.g. Potrafke 2009, Potrafke 2011a for evidence using OECD data and Potrafke 2011b for West Germany). A recent paper by Ferreira and Gyourko (2009)

[25] When using the level of expenditures as dependent variables we get positive and (mostly) significant point estimates for (instrumented) income tax revenues. Hence, additional unanticipated revenues increase the level of expenditures in (almost) every category. However, interaction effects are rarely significant and support the results for mild partisanship such as when using expenditure shares as dependent variables.

fails to find partisan effects at the local level of U.S. cities though, assigning this discrepancy to specifics of the local environment, mainly to competition of localities for mobile people. Using a Regression Discontinuity Design of close elections for municipalities' mayor and fixed effects regression that resembles a Difference-in-Differences estimation we find evidence for mild partisan effects on PIGS provision of German localities for *Youth* expenditures (e.g. child- and youth care). These results are in line with results by Potrafke (2011b). Additionally, we identify lower expenditures for *Productive* goods in 'SPD' dominated municipalities. Lastly, using an instrumental variable approach to assess the reaction of parties to an unexpected increase of revenues we do find mild effects at best. In fact, we are able to identify only few differences between 'SPD' or 'Union' dominated municipalities. Hence, we conclude that partisan politics does not play a major role in German localities. While these results support the results of Ferreira and Gyourko (2009) future research can contribute to the discussion analyzing the importance of higher inter-jurisdictional mobility, intensive competition between localities or a lack of information channels on the ability of local parties to engage in partisan politics.

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Appendix A: Localities Spending Compositions with Left- and Right-Wing Majorities

Table 5.9: Linear regression of expenditure shares on left- and right wing majorities in the local council in a coarsened sample

	Dep. Var.: Expenditure Shares			
	Bavaria & NRW		West Germany	
	SPD (1)	Union (2)	SPD (3)	Union (4)
(A) Administration	0.23	0.17	0.26	-0.10
	(0.35)	(0.38)	(0.17)	(0.17)
(B) Youth	0.25	-0.14	0.58**	-0.10
	(0.46)	(0.43)	(0.28)	(0.30)
(C) Culture	-0.09	-0.13***	-0.03	0.01
	(0.10)	(0.05)	(0.05)	(0.05)
(D) Leisure	-0.24	-0.08	0.27	-0.19
	(0.22)	(0.12)	(0.18)	(0.16)
(E) Productive	0.40	0.86	0.09	0.45
	(0.43)	(0.63)	(0.35)	(0.34)
(F) Debt	-0.57	0.08	-0.30	-0.26
	(0.40)	(0.54)	(0.19)	(0.26)
(G) Other	0.03	-0.76	-0.86*	0.19
	(0.71)	(1.11)	(0.47)	(0.55)
Observations	2167	6765	11039	19120
Year Fixed Effects	✓	✓	✓	✓
Municipality Fixed Effects	✓	✓	✓	✓
Controls	✓	✓	✓	✓

Robust standard errors in parentheses. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. *Source:* Own data collection and calculations.

Appendix B: First Stage Results for Exogenous Revenue Shocks

Table 5.10: First Stage Regressions

	SPD Council		Union Council	
	REV (1)	REV X SPD (2)	REV (3)	REV X Union (4)
(ln) Predicted Error Income Tax	0.69***	0.05	0.56***	0.02
	(0.10)	(0.03)	(0.09)	(0.03)
(ln) Predicted Error Income Tax X SPD	-0.06	0.61***		
	(0.11)	(0.08)		
SPD	-0.01	13.90***		
	(0.01)	(0.12)		
(ln) Predicted Error Income Tax X Union			0.13	0.68***
			(0.10)	(0.06)
Union			0.00	14.28***
			(0.01)	(0.10)
(ln) Population in 1000	0.38***	-0.22	0.39***	0.12
	(0.08)	(0.18)	(0.08)	(0.16)
(ln) Employees	0.14***	0.18*	0.24***	0.03
	(0.04)	(0.11)	(0.06)	(0.09)
(0 − 30km) (ln) Population in 1000	1.02***	1.27**	1.50***	0.42
	(0.15)	(0.55)	(0.15)	(0.38)
Share Population under 20 (County)	-3.19***	-2.92	-4.85***	-1.04
	(0.87)	(1.95)	(0.52)	(1.29)
Share Population over 65 (County)	-1.10*	-3.96*	-2.58***	1.61
	(0.60)	(2.29)	(0.49)	(1.47)
(ln) Debt (County)	0.07***	0.02	0.05***	-0.02
	(0.01)	(0.04)	(0.01)	(0.03)
(ln) Unemployment Rate (County)	0.02	0.05	-0.03**	0.03
	(0.02)	(0.06)	(0.02)	(0.04)
N	8932	8932	19398	19398
F Statistic	354.87***	826.31***	1431.37***	1170.60***
Year Fixed Effects	✓	✓	✓	✓
Municipality Fixed Effects	✓	✓	✓	✓

Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. *Source:* Own data collection and calculations. *Notes:* Municipality clustered robust standard errors are in parentheses. The abbreviation REV stands for income tax revenues.

Appendix C.1: Localities' Spending Composition

Table 5.11: Complete linear regression of expenditure shares on 'SPD' mayors in a coarsened sample using Bavaria and North Rhine-Westphalia

	Mayor						
	Administration (1)	Youth (2)	Culture (3)	Leisure (4)	Productive (5)	Debt (6)	Other (7)
SPD	0.38***	0.22	0.10*	0.12	-0.39*	0.13	-0.56*
	(0.11)	(0.20)	(0.06)	(0.14)	(0.23)	(0.14)	(0.33)
(log) Gesamteinnahmen	-5.94***	-1.24***	-0.29***	0.20	3.07***	2.09***	2.12***
	(0.18)	(0.36)	(0.09)	(0.18)	(0.52)	(0.39)	(0.72)
(ln) Population in 1000	3.79**	8.62***	0.96	1.04	-8.77**	-1.29	-4.35
	(1.66)	(2.86)	(0.65)	(1.67)	(4.11)	(2.16)	(5.42)
(0 − 30km) (ln) Population in 1000	1.03	-29.94***	-0.23	0.29	4.91	-6.90	30.84***
	(3.59)	(6.87)	(1.89)	(2.78)	(8.81)	(4.51)	(11.27)
(ln) Employees	2.62**	0.74	-0.90**	1.46*	-1.41	-0.24	-2.27
	(1.06)	(1.70)	(0.45)	(0.86)	(2.41)	(1.23)	(3.00)
Share Population under 20 (County)	-7.72	32.40	1.18	-17.32	58.37*	-24.22	-42.70
	(19.10)	(25.81)	(7.49)	(16.56)	(32.84)	(24.18)	(62.09)
Share Population over 65 (County)	36.78**	-64.18**	-6.05	-4.34	-49.21	-13.13	100.13*
	(14.95)	(28.16)	(6.17)	(13.61)	(38.64)	(20.18)	(52.51)
(ln) Debt (County)	-0.13	1.37**	0.00	0.09	0.58	0.19	-2.11*
	(0.40)	(0.70)	(0.13)	(0.35)	(0.82)	(0.51)	(1.13)
(ln) Unemployment Rate (County)	-0.54	-1.74***	-0.04	0.80**	-2.29***	-0.73	4.54***
	(0.36)	(0.67)	(0.22)	(0.40)	(0.83)	(0.50)	(1.11)
N	15973	15973	15973	15973	15973	15973	15973
F Statistic	61.73***	5.48***	4.36***	3.22***	9.76***	4.81***	7.34***
Year Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Municipality Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓	✓

Significance levels: * < 0.10, ** < 0.05, *** < 0.01. *Source:* Own data collection and calculations. *Notes:* Municipality clustered robust standard errors are in parentheses.

Table 5.12: Complete linear regression of expenditure shares on 'Union' mayors in a coarsened sample using Bavaria and North Rhine-Westphalia

	Mayor						
	Administration (1)	Youth (2)	Culture (3)	Leisure (4)	Productive (5)	Debt (6)	Other (7)
Union	-0.31***	-0.14	-0.08	0.08	0.17	-0.23	0.51*
	(0.11)	(0.16)	(0.06)	(0.10)	(0.20)	(0.16)	(0.29)
(log) Gesamteinnahmen	-5.03***	-0.81**	-0.26***	0.11	2.46***	1.94***	1.60**
	(0.17)	(0.33)	(0.06)	(0.14)	(0.36)	(0.34)	(0.63)
(ln) Population in 1000	1.97	4.28	1.14*	3.16*	-11.30***	1.88	-1.13
	(1.62)	(3.51)	(0.59)	(1.63)	(3.16)	(2.14)	(4.94)
(0 − 30km) (ln) Population in 1000	3.96	-18.18***	-1.74	-3.17	2.10	-8.28*	25.32***
	(3.20)	(5.62)	(2.84)	(2.82)	(6.37)	(4.65)	(9.43)
(ln) Employees	1.64*	-1.90	-0.41	0.64	-1.50	-0.95	2.47
	(0.86)	(1.58)	(0.36)	(0.85)	(1.97)	(1.28)	(2.78)
Share Population under 20 (County)	-21.13	-4.23	10.19	-5.35	89.15***	-0.70	-67.93
	(16.40)	(25.30)	(9.77)	(18.60)	(28.42)	(23.37)	(43.71)
Share Population over 65 (County)	8.64	-68.83***	-1.56	-6.88	-44.77	12.91	100.50**
	(16.42)	(22.13)	(5.17)	(13.45)	(27.75)	(17.79)	(46.11)
(ln) Debt (County)	0.11	-0.42	-0.02	0.13	-0.86	0.73	0.33
	(0.33)	(0.54)	(0.11)	(0.31)	(0.64)	(0.49)	(0.92)
(ln) Unemployment Rate (County)	-0.30	-1.17**	-0.27	0.10	-2.14***	-0.57	4.35***
	(0.36)	(0.59)	(0.20)	(0.37)	(0.70)	(0.52)	(0.99)
N	18119	18119	18119	18119	18119	18119	18119
F Statistic	49.60***	6.10***	4.12***	2.70***	17.23***	6.17***	10.93***
Year Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Municipality Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓	✓

Significance levels: * < 0.10, ** < 0.05, *** < 0.01. *Source:* Own data collection and calculations. *Notes:* Municipality clustered robust standard errors are in parentheses.

Table 5.13: Complete linear regression of expenditure shares on 'SPD' majority in the local council in a coarsened sample using Bavaria and North Rhine-Westphalia

	Local Council						
	Administration (1)	Youth (2)	Culture (3)	Leisure (4)	Productive (5)	Debt (6)	Other (7)
SPD	0.26*	0.56**	-0.06	0.38**	0.16	-0.15	-1.17**
	(0.15)	(0.28)	(0.06)	(0.19)	(0.36)	(0.20)	(0.50)
(log) Gesamteinnahmen	-6.16***	-2.65***	-0.14*	-0.28	5.18***	3.06***	0.99
	(0.26)	(0.37)	(0.08)	(0.21)	(1.00)	(0.50)	(1.10)
(ln) Population in 1000	5.83***	5.44**	0.76	1.52	-13.90***	-2.84	3.17
	(1.61)	(2.60)	(0.53)	(1.74)	(5.00)	(2.83)	(5.27)
(0 – 30km) (ln) Population in 1000	-2.43	-13.26*	2.56**	-4.23	32.36***	-0.86	-14.13
	(3.73)	(7.05)	(1.01)	(3.37)	(8.17)	(3.96)	(12.76)
(ln) Employees	1.51	1.67	-0.23	1.30	3.24	2.05	-9.54***
	(1.26)	(1.53)	(0.38)	(0.84)	(2.58)	(1.96)	(3.15)
Share Population under 20 (County)	-10.54	66.81**	-12.41**	19.13	-84.73*	21.79	-0.05
	(20.83)	(31.55)	(6.04)	(12.52)	(49.58)	(26.90)	(53.84)
Share Population over 65 (County)	2.70	-32.94	3.61	-21.53	3.92	-10.21	54.45
	(14.18)	(26.02)	(5.20)	(15.59)	(31.71)	(19.20)	(47.86)
(ln) Debt (County)	0.07	0.43	0.02	-0.03	-0.99	0.76*	-0.26
	(0.30)	(0.49)	(0.11)	(0.24)	(1.05)	(0.42)	(1.07)
(ln) Unemployment Rate (County)	0.23	0.40	0.10	0.13	-2.31	0.12	1.33
	(0.48)	(0.74)	(0.18)	(0.45)	(1.43)	(0.62)	(1.68)
constant	91.62***	35.29**	0.89	1.85	-93.17***	-67.93***	131.45***
	(10.63)	(17.23)	(3.10)	(8.14)	(23.55)	(14.69)	(38.18)
N	9419	9419	9419	9419	9419	9419	9419
F Statistic	45.68***	8.38***	1.88**	2.80***	6.00***	5.22***	3.38***
Year Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Municipality Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓	✓

Significance levels: * < 0.10, ** < 0.05, *** < 0.01. *Source:* Own data collection and calculations. *Notes:* Municipality clustered robust standard errors are in parentheses.

Table 5.14: Complete linear regression of expenditure shares on 'Union' majority in the local council in a coarsened sample using Bavaria and North Rhine-Westphalia

	Local Council						
	Administration (1)	Youth (2)	Culture (3)	Leisure (4)	Productive (5)	Debt (6)	Other (7)
Union	-0.12	0.08	-0.01	-0.19	0.20	-0.20	0.23
	(0.15)	(0.24)	(0.04)	(0.12)	(0.24)	(0.23)	(0.41)
(log) Gesamteinnahmen	-5.59***	-1.68***	-0.18***	-0.04	2.41***	2.32***	2.77***
	(0.16)	(0.34)	(0.06)	(0.18)	(0.38)	(0.27)	(0.59)
(ln) Population in 1000	4.26***	3.02	0.80**	0.95	-10.02***	2.13	-1.14
	(1.13)	(2.22)	(0.36)	(1.32)	(2.92)	(1.96)	(3.84)
(0 – 30km) (ln) Population in 1000	-0.35	-5.14	1.88**	0.32	13.77***	-11.01***	0.54
	(2.58)	(5.25)	(0.82)	(2.57)	(5.26)	(4.09)	(8.40)
(ln) Employees	1.44**	0.07	-0.10	0.94	0.85	-1.03	-2.18
	(0.71)	(1.17)	(0.25)	(0.75)	(1.49)	(1.03)	(1.98)
Share Population under 20 (County)	-25.51*	21.83	-6.98	4.53	22.40	-8.58	-7.69
	(13.19)	(25.58)	(4.83)	(10.15)	(22.54)	(18.47)	(34.63)
Share Population over 65 (County)	5.14	11.83	-1.73	-7.31	6.40	-11.46	-2.89
	(11.27)	(22.68)	(3.85)	(10.87)	(22.11)	(16.66)	(32.18)
(ln) Debt (County)	-0.48**	-1.72***	-0.04	-0.22	-1.04**	1.22***	2.27***
	(0.21)	(0.46)	(0.07)	(0.21)	(0.49)	(0.29)	(0.72)
(ln) Unemployment Rate (County)	-0.08	-0.07	-0.05	-0.18	-1.54**	0.58	1.35
	(0.37)	(0.56)	(0.09)	(0.32)	(0.66)	(0.51)	(0.90)
constant	93.54***	58.45***	2.23	-1.82	-34.86**	-23.78**	6.25
	(7.96)	(14.74)	(2.55)	(7.88)	(15.92)	(10.92)	(22.64)
N	20246	20246	20246	20246	20246	20246	20246
F Statistic	69.96***	7.40***	3.81***	2.05***	11.36***	7.66***	7.06***
Year Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Municipality Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓	✓

Significance levels: * < 0.10, ** < 0.05, *** < 0.01. *Source:* Own data collection and calculations. *Notes:* Municipality clustered robust standard errors are in parentheses.

Table 5.15: Complete linear regression of expenditure shares on 'SPD' mayors in a coarsened sample

	Mayor						
	Administration (1)	Youth (2)	Culture (3)	Leisure (4)	Productive (5)	Debt (6)	Other (7)
SPD	0.38***	0.22	0.10*	0.12	-0.39*	0.13	-0.56*
	(0.11)	(0.20)	(0.06)	(0.14)	(0.23)	(0.14)	(0.33)
(log) Gesamteinnahmen	-5.94***	-1.24***	-0.29***	0.20	3.07***	2.09***	2.12***
	(0.18)	(0.36)	(0.09)	(0.18)	(0.52)	(0.39)	(0.72)
(ln) Population in 1000	3.79**	8.62***	0.96	1.04	-8.77**	-1.29	-4.35
	(1.66)	(2.86)	(0.65)	(1.67)	(4.11)	(2.16)	(5.42)
$(0-30\text{km})$ (ln) Population in 1000	1.03	-29.94***	-0.23	0.29	4.91	-6.90	30.84***
	(3.59)	(6.87)	(1.89)	(2.78)	(8.81)	(4.51)	(11.27)
(ln) Employees	2.62**	0.74	-0.90**	1.46*	-1.41	-0.24	-2.27
	(1.06)	(1.70)	(0.45)	(0.86)	(2.41)	(1.23)	(3.00)
Share Population under 20 (County)	-7.72	32.40	1.18	-17.32	58.37*	-24.22	-42.70
	(19.10)	(25.81)	(7.49)	(16.56)	(32.84)	(24.18)	(62.09)
Share Population over 65 (County)	36.78**	-64.18**	-6.05	-4.34	-49.21	-13.13	100.13*
	(14.95)	(28.16)	(6.17)	(13.61)	(38.64)	(20.18)	(52.51)
(ln) Debt (County)	-0.13	1.37**	0.00	0.09	0.58	0.19	-2.11*
	(0.40)	(0.70)	(0.13)	(0.35)	(0.82)	(0.51)	(1.13)
(ln) Unemployment Rate (County)	-0.54	-1.74***	-0.04	0.80**	-2.29***	-0.73	4.54***
	(0.36)	(0.67)	(0.22)	(0.40)	(0.83)	(0.50)	(1.11)
N	15973	15973	15973	15973	15973	15973	15973
F Statistic	61.73***	5.48***	4.36***	3.22***	9.76***	4.81***	7.34***
Year Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Municipality Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓	✓

Significance levels: * < 0.10, ** < 0.05, *** < 0.01. *Source:* Own data collection and calculations. *Notes:* Municipality clustered robust standard errors are in parentheses.

Table 5.16: Complete linear regression of expenditure shares on 'Union' mayors in a coarsened sample

	Mayor						
	Administration (1)	Youth (2)	Culture (3)	Leisure (4)	Productive (5)	Debt (6)	Other (7)
Union	-0.31***	-0.14	-0.08	0.08	0.17	-0.23	0.51*
	(0.11)	(0.16)	(0.06)	(0.10)	(0.20)	(0.16)	(0.29)
(log) Gesamteinnahmen	-5.03***	-0.81**	-0.26***	0.11	2.46***	1.94***	1.60**
	(0.17)	(0.33)	(0.06)	(0.14)	(0.36)	(0.34)	(0.63)
(ln) Population in 1000	1.97	4.28	1.14*	3.16*	-11.30***	1.88	-1.13
	(1.62)	(3.51)	(0.59)	(1.63)	(3.16)	(2.14)	(4.94)
$(0-30\text{km})$ (ln) Population in 1000	3.96	-18.18***	-1.74	-3.17	2.10	-8.28*	25.32***
	(3.20)	(5.62)	(2.84)	(2.82)	(6.37)	(4.65)	(9.43)
(ln) Employees	1.64*	-1.90	-0.41	0.64	-1.50	-0.95	2.47
	(0.86)	(1.58)	(0.36)	(0.85)	(1.97)	(1.28)	(2.78)
Share Population under 20 (County)	-21.13	-4.23	10.19	-5.35	89.15***	-0.70	-67.93
	(16.40)	(25.30)	(9.77)	(18.60)	(28.42)	(23.37)	(43.71)
Share Population over 65 (County)	8.64	-68.83***	-1.56	-6.88	-44.77	12.91	100.50**
	(16.42)	(22.13)	(5.17)	(13.45)	(27.75)	(17.79)	(46.11)
(ln) Debt (County)	0.11	-0.42	-0.02	0.13	-0.86	0.73	0.33
	(0.33)	(0.54)	(0.11)	(0.31)	(0.64)	(0.49)	(0.92)
(ln) Unemployment Rate (County)	-0.30	-1.17**	-0.27	0.10	-2.14***	-0.57	4.35***
	(0.36)	(0.59)	(0.20)	(0.37)	(0.70)	(0.52)	(0.99)
N	18119	18119	18119	18119	18119	18119	18119
F Statistic	49.60***	6.10***	4.12***	2.70***	17.23***	6.17***	10.93***
Year Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Municipality Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓	✓

Significance levels: * < 0.10, ** < 0.05, *** < 0.01. *Source:* Own data collection and calculations. *Notes:* Municipality clustered robust standard errors are in parentheses.

Table 5.17: Complete linear regression of expenditure shares on 'SPD' majority in the local council in a coarsened sample

	Local Council						
	Administration (1)	Youth (2)	Culture (3)	Leisure (4)	Productive (5)	Debt (6)	Other (7)
SPD	0.26*	0.56**	-0.06	0.38**	0.16	-0.15	-1.17**
	(0.15)	(0.28)	(0.06)	(0.19)	(0.36)	(0.20)	(0.50)
(log) Gesamteinnahmen	-6.16***	-2.65***	-0.14*	-0.28	5.18***	3.06***	0.99
	(0.26)	(0.37)	(0.08)	(0.21)	(1.00)	(0.50)	(1.10)
(ln) Population in 1000	5.83***	5.44**	0.76	1.52	-13.90***	-2.84	3.17
	(1.61)	(2.60)	(0.53)	(1.74)	(5.00)	(2.83)	(5.27)
(0 − 30km) (ln) Population in 1000	-2.43	-13.26*	2.56**	-4.23	32.36***	-0.86	-14.13
	(3.73)	(7.05)	(1.01)	(3.37)	(8.17)	(3.96)	(12.76)
(ln) Employees	1.51	1.67	-0.23	1.30	3.24	2.05	-9.54***
	(1.26)	(1.53)	(0.38)	(0.84)	(2.58)	(1.96)	(3.15)
Share Population under 20 (County)	-10.54	66.81**	-12.41**	19.13	-84.73*	21.79	-0.05
	(20.83)	(31.55)	(6.04)	(12.52)	(49.58)	(26.90)	(53.84)
Share Population over 65 (County)	2.70	-32.94	3.61	-21.53	3.92	-10.21	54.45
	(14.18)	(26.02)	(5.20)	(15.59)	(31.71)	(19.20)	(47.86)
(ln) Debt (County)	0.07	0.43	0.02	-0.03	-0.99	0.76*	-0.26
	(0.30)	(0.49)	(0.11)	(0.24)	(1.05)	(0.42)	(1.07)
(ln) Unemployment Rate (County)	0.23	0.40	0.10	0.13	-2.31	0.12	1.33
	(0.48)	(0.74)	(0.18)	(0.45)	(1.43)	(0.62)	(1.68)
constant	91.62***	35.29**	0.89	1.85	-93.17***	-67.93***	131.45***
	(10.63)	(17.23)	(3.10)	(8.14)	(23.55)	(14.69)	(38.18)
N	9419	9419	9419	9419	9419	9419	9419
F Statistic	45.68***	8.38***	1.88**	2.80***	6.00***	5.22***	3.38***
Year Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Municipality Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓	✓

Significance levels: * < 0.10, ** < 0.05, *** < 0.01. *Source:* Own data collection and calculations. *Notes:* Municipality clustered robust standard errors are in parentheses.

Table 5.18: Complete linear regression of expenditure shares on 'Union' majority in the local council in a coarsened sample

	Local Council						
	Administration (1)	Youth (2)	Culture (3)	Leisure (4)	Productive (5)	Debt (6)	Other (7)
Union	-0.12	0.08	-0.01	-0.19	0.20	-0.20	0.23
	(0.15)	(0.24)	(0.04)	(0.12)	(0.24)	(0.23)	(0.41)
(log) Gesamteinnahmen	-5.59***	-1.68***	-0.18***	-0.04	2.41***	2.32***	2.77***
	(0.16)	(0.34)	(0.06)	(0.18)	(0.38)	(0.27)	(0.59)
(ln) Population in 1000	4.26***	3.02	0.80**	0.95	-10.02***	2.13	-1.14
	(1.13)	(2.22)	(0.36)	(1.32)	(2.92)	(1.96)	(3.84)
(0 − 30km) (ln) Population in 1000	-0.35	-5.14	1.88**	0.32	13.77***	-11.01***	0.54
	(2.58)	(5.25)	(0.82)	(2.57)	(5.26)	(4.09)	(8.40)
(ln) Employees	1.44**	0.07	-0.10	0.94	0.85	-1.03	-2.18
	(0.71)	(1.17)	(0.25)	(0.75)	(1.49)	(1.03)	(1.98)
Share Population under 20 (County)	-25.51*	21.83	-6.98	4.53	22.40	-8.58	-7.69
	(13.19)	(25.58)	(4.83)	(10.15)	(22.54)	(18.47)	(34.63)
Share Population over 65 (County)	5.14	11.83	-1.73	-7.31	6.40	-11.46	-2.89
	(11.27)	(22.68)	(3.85)	(10.87)	(22.11)	(16.66)	(32.18)
(ln) Debt (County)	-0.48**	-1.72***	-0.04	-0.22	-1.04**	1.22***	2.27***
	(0.21)	(0.46)	(0.07)	(0.21)	(0.49)	(0.29)	(0.72)
(ln) Unemployment Rate (County)	-0.08	-0.07	-0.05	-0.18	-1.54**	0.58	1.35
	(0.37)	(0.56)	(0.09)	(0.32)	(0.66)	(0.51)	(0.90)
constant	93.54***	58.45***	2.23	-1.82	-34.86**	-23.78**	6.25
	(7.96)	(14.74)	(2.55)	(7.88)	(15.92)	(10.92)	(22.64)
N	20246	20246	20246	20246	20246	20246	20246
F Statistic	69.96***	7.40***	3.81***	2.05***	11.36***	7.66***	7.06***
Year Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Municipality Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓	✓

Significance levels: * < 0.10, ** < 0.05, *** < 0.01. *Source:* Own data collection and calculations. *Notes:* Municipality clustered robust standard errors are in parentheses.

Table 5.19: Complete linear regression of expenditure shares on 'SPD' mayors in an instrumented and coarsened sample

	Mayor						
	(1) Administration b/se	(2) Youth b/se	(3) Culture b/se	(4) Leisure b/se	(5) Productive b/se	(6) Debt b/se	(7) Other b/se
(ln) Income Tax Revenue	-1.78	1.03	0.68	-0.36	1.30	-0.20	-0.68
	(1.08)	(1.58)	(0.55)	(1.01)	(2.58)	(1.82)	(3.19)
(ln) Income Tax Revenue X SPD	-0.48	0.46	-0.41	1.78	-0.33	-0.29	-0.72
	(1.42)	(1.85)	(0.59)	(1.29)	(2.85)	(2.21)	(3.59)
SPD	7.28	-6.12	5.86	-24.74	4.10	4.16	9.46
	(19.89)	(25.84)	(8.19)	(17.99)	(39.84)	(30.86)	(50.12)
(ln) Population in 1000	2.68	8.93***	0.49	1.66	-9.30**	-0.45	-4.00
	(2.04)	(3.13)	(0.69)	(1.97)	(4.49)	(2.36)	(5.86)
(0 − 30km) (ln) Population in 1000	0.36	-33.66***	-1.89	0.34	3.09	-4.43	36.20***
	(5.04)	(8.41)	(2.41)	(3.77)	(10.43)	(5.90)	(12.98)
(ln) Employees	4.13***	0.52	-0.85	1.19	-1.62	-0.14	-3.23
	(1.22)	(1.71)	(0.58)	(0.95)	(2.31)	(1.44)	(3.06)
Share Population under 20 (County)	-30.27	32.67	2.39	-19.90	64.98*	-15.38	-34.48
	(21.55)	(26.15)	(7.67)	(17.74)	(35.40)	(25.79)	(60.97)
Share Population over 65 (County)	37.28**	-62.11**	-4.41	0.09	-46.28	-4.67	80.10*
	(17.66)	(27.71)	(6.99)	(14.42)	(33.08)	(22.07)	(47.16)
(ln) Debt (County)	0.00	0.89	0.01	0.08	0.69	-0.05	-1.62
	(0.41)	(0.71)	(0.13)	(0.36)	(0.80)	(0.54)	(1.13)
(ln) Unemployment Rate (County)	-0.24	-1.28*	-0.08	0.74*	-2.80***	-0.70	4.37***
	(0.43)	(0.68)	(0.23)	(0.41)	(0.84)	(0.51)	(1.09)
N	15441	15441	15441	15441	15441	15441	15441
F Statistic	6.77***	3.99***	1.98***	2.59***	7.94***	3.08***	6.90***
Weak Instrument Test†	111.89	111.89	111.89	111.89	111.89	111.89	111.89
Year Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Municipality Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓	✓

Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. *Source:* Own data collection and calculations. *Notes:* Municipality clustered robust standard errors are in parentheses. †Kleibergen and Paap (2006) rank F-statistic for stationary data.

Table 5.20: Complete linear regression of expenditure shares on 'Union' mayors in an instrumented and coarsened sample

	Mayor						
	(1) Administration b/se	(2) Youth b/se	(3) Culture b/se	(4) Leisure b/se	(5) Productive b/se	(6) Debt b/se	(7) Other b/se
(ln) Income Tax Revenue	-1.37	-0.74	0.18	0.43	2.09	3.34	-3.94
	(1.00)	(1.55)	(0.32)	(0.82)	(1.66)	(2.46)	(2.51)
(ln) Income Tax Revenue X Union	-0.11	1.54	-0.15	1.74	-2.70	-1.37	1.05
	(1.60)	(2.50)	(0.53)	(1.69)	(2.98)	(3.17)	(4.15)
Union	1.24	-21.33	1.93	-23.84	37.23	18.67	-13.89
	(21.94)	(34.39)	(7.30)	(23.29)	(40.98)	(43.61)	(57.06)
(ln) Population in 1000	2.82	3.82	1.14*	2.71	-11.97***	0.91	0.57
	(1.97)	(3.80)	(0.64)	(1.84)	(3.60)	(2.44)	(5.35)
(0 − 30km) (ln) Population in 1000	4.20	-19.54***	-2.12	-7.61*	5.22	-12.62**	32.47***
	(4.22)	(7.00)	(3.24)	(4.01)	(8.06)	(5.96)	(11.44)
(ln) Employees	1.63	-1.63	-0.45	0.29	-2.63	-1.55	4.34
	(1.07)	(1.70)	(0.36)	(0.90)	(2.17)	(1.86)	(3.09)
Share Population under 20 (County)	-46.61**	-8.72	10.47	-5.92	98.56***	18.72	-66.50
	(18.52)	(25.43)	(10.18)	(19.82)	(30.69)	(25.09)	(44.67)
Share Population over 65 (County)	13.53	-73.00***	-0.42	-4.48	-42.77	15.78	91.36*
	(16.29)	(23.53)	(5.37)	(14.29)	(30.80)	(21.11)	(48.89)
(ln) Debt (County)	0.19	-0.63	-0.02	0.08	-0.94	0.63	0.69
	(0.38)	(0.56)	(0.12)	(0.34)	(0.69)	(0.52)	(0.96)
(ln) Unemployment Rate (County)	0.19	-0.86	-0.31	0.02	-2.28***	-0.88	4.13***
	(0.39)	(0.62)	(0.21)	(0.38)	(0.74)	(0.57)	(1.04)
N	17603	17603	17603	17603	17603	17603	17603
F Statistic	5.46***	4.96***	2.20***	2.44***	14.96***	4.21***	9.42***
Weak Instrument Test†	114.37	114.37	114.37	114.37	114.37	114.37	114.37
Year Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Municipality Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓	✓

Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. *Source:* Own data collection and calculations. *Notes:* Municipality clustered robust standard errors are in parentheses. †Kleibergen and Paap (2006) rank F-statistic for stationary data.

Table 5.21: Complete linear regression of expenditure shares on 'SPD' majority in the local council in an instrumented and coarsened sample

	Local Council						
	(1) Administration b/se	(2) Youth b/se	(3) Culture b/se	(4) Leisure b/se	(5) Productive b/se	(6) Debt b/se	(7) Other b/se
(ln) Income Tax Revenue	-6.11**	-3.98	-0.06	0.68	-0.84	0.87	9.44*
	(2.61)	(3.00)	(0.23)	(0.90)	(2.30)	(1.79)	(5.69)
(ln) Income Tax Revenue X SPD	5.04	-1.34	-0.23	-1.95	-1.63	1.28	-1.18
	(3.11)	(4.00)	(0.54)	(1.71)	(3.39)	(3.24)	(6.83)
SPD	-69.64	19.11	3.10	27.47	22.62	-18.02	15.37
	(43.19)	(55.62)	(7.52)	(23.83)	(47.07)	(45.03)	(94.88)
(ln) Population in 1000	6.80***	4.23	0.64	0.53	-12.50**	-2.22	2.52
	(2.57)	(3.28)	(0.61)	(1.98)	(5.65)	(2.83)	(6.66)
(0 − 30km) (ln) Population in 1000	-5.37	-5.00	2.79**	-1.83	38.63***	-2.57	-26.66*
	(5.29)	(8.39)	(1.19)	(3.96)	(9.07)	(5.23)	(14.02)
(ln) Employees	1.90	3.27*	-0.10	1.16	3.01	1.84	-11.09***
	(1.53)	(1.69)	(0.38)	(0.89)	(2.78)	(2.12)	(3.23)
Share Population under 20 (County)	-32.90	46.28	-12.80**	12.66	-70.95	32.18	25.53
	(22.78)	(32.42)	(6.25)	(13.81)	(54.04)	(27.96)	(55.60)
Share Population over 65 (County)	23.08	-38.62	3.32	-23.90	-6.31	1.66	40.76
	(24.04)	(30.97)	(5.97)	(17.47)	(34.20)	(24.06)	(56.23)
(ln) Debt (County)	-0.66	0.08	-0.02	-0.10	-0.08	1.21***	-0.44
	(0.42)	(0.52)	(0.11)	(0.25)	(1.21)	(0.43)	(1.26)
(ln) Unemployment Rate (County)	1.24**	1.22	0.00	0.18	-3.35**	-0.14	0.85
	(0.62)	(0.78)	(0.18)	(0.48)	(1.58)	(0.66)	(1.83)
N	8932	8932	8932	8932	8932	8932	8932
F Statistic	5.80***	5.72***	0.85	1.73**	4.47***	3.45***	3.32***
Weak Instrument Test†	28.15	28.15	28.15	28.15	28.15	28.15	28.15
Year Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Municipality Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓	✓

Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. *Source:* Own data collection and calculations. *Notes:* Municipality clustered robust standard errors are in parentheses. †Kleibergen and Paap (2006) rank F-statistic for stationary data.

Table 5.22: Complete linear regression of expenditure shares on 'Union' majority in the local council in an instrumented and coarsened sample

	Local Council						
	(1) Administration b/se	(2) Youth b/se	(3) Culture b/se	(4) Leisure b/se	(5) Productive b/se	(6) Debt b/se	(7) Other b/se
(ln) Income Tax Revenue	0.51	2.75	-0.29	-0.55	2.12	1.04	-5.58
	(0.94)	(2.34)	(0.20)	(0.79)	(2.08)	(1.27)	(3.94)
(ln) Income Tax Revenue X Union	-4.39**	-1.64	0.22	2.12	-7.16**	-0.90	11.75**
	(2.16)	(3.19)	(0.36)	(1.52)	(2.87)	(1.86)	(5.49)
Union	62.43**	23.56	-3.11	-30.48	102.55**	12.69	-167.66**
	(30.86)	(45.60)	(5.18)	(21.64)	(40.92)	(26.53)	(78.44)
(ln) Population in 1000	1.50	0.03	0.72*	0.64	-8.34**	3.35	2.10
	(1.52)	(2.57)	(0.40)	(1.48)	(3.24)	(2.11)	(4.75)
$(0-30\text{km})$ (ln) Population in 1000	-2.16	-9.36	2.45***	0.30	17.36***	-11.19**	2.60
	(3.97)	(5.78)	(0.94)	(3.06)	(6.69)	(4.96)	(10.70)
(ln) Employees	2.69***	-0.27	0.06	0.98	-0.00	-1.64	-1.82
	(0.97)	(1.34)	(0.26)	(0.84)	(1.71)	(1.15)	(2.47)
Share Population under 20 (County)	-37.87**	40.55	-7.34	4.57	27.91	-3.58	-24.24
	(15.95)	(27.63)	(4.91)	(11.48)	(26.67)	(20.71)	(42.74)
Share Population over 65 (County)	29.30*	20.65	-1.37	-12.17	21.24	-9.92	-47.73
	(15.18)	(26.96)	(4.08)	(12.44)	(26.17)	(18.76)	(42.24)
(ln) Debt (County)	-0.97***	-1.89***	-0.03	-0.19	-1.23**	1.32***	2.99***
	(0.30)	(0.53)	(0.08)	(0.23)	(0.56)	(0.34)	(0.88)
(ln) Unemployment Rate (County)	0.71	0.53	-0.09	-0.30	-1.58**	0.27	0.46
	(0.46)	(0.60)	(0.10)	(0.33)	(0.75)	(0.53)	(1.07)
N	19398	19398	19398	19398	19398	19398	19398
F Statistic	8.19***	4.35***	2.44***	1.66**	8.24***	4.74***	4.49***
Weak Instrument Test†	56.15	56.15	56.15	56.15	56.15	56.15	56.15
Year Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Municipality Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓	✓

Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. *Source:* Own data collection and calculations. *Notes:* Municipality clustered robust standard errors are in parentheses. †Kleibergen and Paap (2006) rank F-statistic for stationary data.

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1987	Born in Schwerte (North Rhine-Westphalia), Germany
2006	High School Diploma St.-Pius-Gymnasium, Coesfeld
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