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Martin Micheli

Local Governments' Indebtedness and Its Impact on Real Estate Prices

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Universitätsstr. 150, 44801 Bochum, Germany

Technische Universität Dortmund, Department of Economic and Social Sciences
Vogelpothsweg 87, 44227 Dortmund, Germany

Universität Duisburg-Essen, Department of Economics
Universitätsstr. 12, 45117 Essen, Germany

Rheinisch-Westfälisches Institut für Wirtschaftsforschung (RWI)
Hohenzollernstr. 1-3, 45128 Essen, Germany

Editors

Prof. Dr. Thomas K. Bauer
RUB, Department of Economics, Empirical Economics
Phone: +49 (0) 234/3 22 83 41, e-mail: thomas.bauer@rub.de

Prof. Dr. Wolfgang Leininger
Technische Universität Dortmund, Department of Economic and Social Sciences
Economics – Microeconomics
Phone: +49 (0) 231/7 55-3297, e-mail: W.Leininger@wiso.uni-dortmund.de

Prof. Dr. Volker Clausen
University of Duisburg-Essen, Department of Economics
International Economics
Phone: +49 (0) 201/1 83-3655, e-mail: vclausen@vwl.uni-due.de

Prof. Dr. Roland Döhrn, Prof. Dr. Manuel Frondel, Prof. Dr. Jochen Kluve
RWI, Phone: +49 (0) 201/81 49-213, e-mail: presse@rwi-essen.de

Editorial Office

Sabine Weiler
RWI, Phone: +49 (0) 201/81 49-213, e-mail: sabine.weiler@rwi-essen.de

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Martin Micheli[1]

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Abstract

In this paper, we estimate the causal effect of public debt on real estate prices and rental prices. We identify shocks to investment credits of self-governed cities in Germany and control for potential benefits such as an increased supply of public goods, which might come in hand with increased indebtedness. Using spatial variation across self-governed cities allows us to estimate this effect. We find that shocks to public debt have a significant negative effect on apartment prices. Rental prices, on the other hand, do not seem to be affected by public debt. Tenants care more about the current and less about the future tax burden.

JEL Classification: R30, R51

Keywords: Real estate prices; local government debt

February 2016

1 MartinMicheli, RWI. – The author thanks Immobilienscout24 for making available the dataset on asking prices for German properties and Thomas K. Bauer, Roland Döhrn, Heinz Gebhardt, Hermann Rappen, Torsten Schmidt, Simeon Vosen and participants of the 59th North American Meeting of the Regional Science Association International (Ottawa), the 6th Summer Conference in Regional Science (Dortmund) and the 3rd Workshop Immobilienökonomie (Essen) for useful comments on earlier versions of the paper. - *All correspondence to: Martin Micheli, RWI, Hohenzollernstr. 1-3, 45128 Essen, Germany, email: Martin.Micheli@rwi-essen.de*

1 Introduction

Local infrastructure is one of the most important factors driving real estate prices. It is therefore not surprising that there is a comprehensive body of literature evaluating the effect of public goods such as education (Downes and Zabel, 2002; Gibbons and Machin, 2003) or infrastructure (Bajic, 1983; Laakso, 1992; Bowes and Ihlanfeldt, 2001) on real estate prices. In particular the effect of transport facilities has been studied extensively. As policymakers need estimates for the benefits of planned or conducted improvements in infrastructure to make informed decisions, the evaluation of such projects has been the focus of various studies, see Ryan (1999) or RICS (2002) for surveys of the literature. Overall, the literature suggests a positive effect of infrastructure investment on property prices. However, there are various channels, through which improved infrastructure might affect real estate prices. Bowes and Ihlanfeldt (2001), for example, disentangle the effect of rail transit stations into potentially positive effects of lower commuting costs and higher attractiveness for retail activity from potentially negative effects, such as higher emissions and higher criminality. However, the possibility of a negative effect due to an increase in public debt has widely been neglected, which potentially results in an overestimation of the usefulness of such projects.

Following Barro (1974), an increase in public debt reduces net worth of the private sector as the government has to pay for increased indebtedness at some point in the future, either via an increase in dues or taxes or by reducing the supply of public goods. Rational inhabitants will foresee the necessity of adjustments in the public sector, immediately resulting in lower real estate prices (Eichenberger and Stadelmann, 2010). Rents, on the other hand, will only be affected if an increase in indebtedness results in higher taxes or in a lower level of public goods local governments are providing. This might be, for example, an increase in property taxes, which can be shifted from the property owner to the tenant, if specified in the rental contract, or a reduction in government expenditures for education. Increased indebtedness however, does not affect tenants as they can easily avoid paying for public debt by relocating in case of an adjustment in tax rates leaving real estate owners at risk.

Using spatial variation, we estimate the causal effect of an increase in local governments' indebtedness on apartment prices in Germany, controlling for possible benefits due to an increase in public goods and services that might come in hand with this increased indebtedness. We find that an increase in local governments' indebtedness per capita lowers real estate prices with a factor larger than one. Taking into account that more than one individual inhabits the average apartment, this reduces the factor to about one.

Additionally to that, we find that local government debt seems to be less important for tenants. Tenants seem to care more about the current tax burden than about increased public indebtedness, which should result in a higher tax burden in the future, as they can avoid paying for increased public debt by relocating in case of tax increases.

The outline of this paper is as follows: The next section surveys the related literature on the relationship between public debt and real estate prices. Section 3 introduces the dataset, Section 4 presents the strategy to identify shocks to local governments' indebtedness and to disentangle negative effects of higher public debt from possible positive effects due to an increased supply of public goods. Section 5 presents the estimation strategy, Section 6 presents the results and Section 7 concludes.

2 Related Literature

The interdependency between local public finances and real estate prices has widely been discussed in the literature. Most research has focused on the relationship between local public income and expenditures and real estate prices. In a seminal contribution, Tiebout (1956) introduces the idea that local governments offer a basket of public goods and collect taxes to finance these public goods. Given consumer mobility, consumers choose that community to live in, which matches their individual tastes best. This way, differences in the level of real estate prices are general equilibrium outcomes in steady state due to consumers' differing preference for public goods.

Tiebout's argument has been discussed extensively and has been central to empirical studies in regional sciences. Early empirical tests include Oates (1969) and Brueckner (1979). Chaudry-Shah (1988) and Dowding et al. (1994) survey the literature. However, almost 60 years after the contribution by Tiebout (1956), there still is no consensus on the validity of this hypothesis.

The assumption of perfectly mobile consumers is intellectually appealing and gives valuable insights into the equilibrium determining mechanism of real estate prices in a model with differing local governments' tax and spending plans and mobile consumers. However, it is reasonable to assume that mobility is not perfect. Consumer relocation might be associated with substantial costs, which might dominate welfare losses due to an unfavorable spending decision by the local government. That is why it is important to evaluate investment decisions carefully and to only conduct those investments that are favorable given residents' preferences.

The literature on the evaluation of the benefits of public goods in terms of real estate prices typically neglects the negative effects of increased public debt, which could be

associated with large scale investment projects and this way potentially overestimates the benefits of such projects. To get the true benefits of such investment projects it is important to have an estimate for the effect of increased public indebtedness.

To our knowledge, there is only one paper trying to estimate the causal effect of a shock to local government's indebtedness. MacKay (2011) identifies the growing awareness of unfunded pension obligations in San Diego as a shock to local public debt and assesses this as a natural experiment. He finds that the growing awareness of this additional liability has led to a decrease of local house prices by a factor greater than one.

3 Data

To estimate the causal effect of public debt on real estate prices we use data on apartments offered for sale or rent in adjacent self-governed cities in North Rhine-Westphalia (NRW) and data on public indebtedness in these cities. We restrict our analysis to apartments as the rental market for houses is negligible in size, at least in comparison to the rental market for apartments. Including houses would therefore complicate the analysis of differences in the real estate and the rental market. Real estate data are provided by ImmobilienScout24, Germany's largest online real estate marketplace with a self-reported market share of about 50% of all real estate transactions in Germany (Georgi and Barkow, 2010). At this online marketplace, potential sellers and landlords can place ads to sell or rent out their properties. Therefore, real estate prices and rents in this study refer to asking prices, not transaction prices.

Due to the lack of publicly available information on real estate transactions, asking prices are widely used in Germany.[1] Distortions due to the use of asking prices in contrast to transaction prices should be less of an issue for at least three reasons. First, self-reported house prices have proven to be quite useful in the literature, e.g. Davis (2011). Second, the dataset by ImmobilienScout24 only includes objects that are available for sale or rent, representing the first stage of a real estate transaction. Therefore, these quasi self-reported prices should reflect the assessment of well-informed individuals, only. Third, price differentials between asking prices as reported by ImmobilienScout24 and transaction prices do not seem to follow a predictable pattern and seem to be about 15% higher than transaction prices, at least for houses in rural areas in Rheinland-Palatinate (Dinkel and Kurzrock, 2012).

[1] Self-governed cities in NRW use a similar dataset by ImmobilienScout24 when reporting on the stance of the real estate market (AG Wohnungsmarkt Ruhr, 2012). Other studies that use ImmobilienScout24 data are e.g. Bauer et al. (2013) and RWI (2013).

The dataset by ImmobilienScout24 is available at monthly frequency and covers the time period from January 2007 to June 2014. In this study, we use advertisements in the time period from January 2007 to December 2013.[2] The dataset indicates an object's asking price as well as various object specific characteristics such as living space, the number of rooms, and the year of construction.[3] To approximate the transaction price and to eliminate potential biases due to differences in objects' advertisement period we only use the last observation before an advert is set as inactive. Inactive objects do not enter any search queries and most probably indicate a transaction. However, there also are inactive objects that are set as active again and this way reenter search queries. We interpret this as the owner expecting to rent out or sell the property, therefore setting the ad as inactive. However, for some reason the transaction does not take place so that the property is again offered at the marketplace of ImmobilienScout24. We therefore only use the last observation of objects that do not reenter the market until June 2014. Summary statistics, subdivided into the different border regions of adjacent cities, for objects advertised for sale are reported in Table A.1, summary statistics for the rental market are reported in Table A.2.[4]

Information on self-governed cities' fiscal positions are available at IT.NRW, the statistical office in NRW. IT.NRW reports self-governed cities' credit positions, subdivided into two categories. These are credits for investment and liquidity credits. Credit for investment, *Fundierte Schulden*, refer to debt accumulated to finance investment projects, mostly consisting of infrastructure spending such as new roads or investment related to cultural offerings such as museums or schools. Cities are prohibited by law to use investment credit to finance running deficits. Liquidity credit, *Kassenkredite*, are used to buffer temporary liquidity shortages. Data on these two credit positions are available on annual frequency for the years 1995 to 2013. We divide local governments' debt positions

[2]In our analysis we exclude apartments where object condition has been reported as 'dilapidated' or 'by arrangement'. Given that living in such objects seems hardly possible without substantial additional investments, the underlying price mechanism might substantially differ from typical objects advertised. Additionally to that, we exclude objects that are categorized as 'other' as well as extreme values. As the dataset consists of user entries this makes the dataset prone to false entries. For apartments for sale we exclude the highest and the lowest one percent for the variables 'apartment price', 'square meter price' and 'living space' as well as the highest one percent for the variable 'number of rooms' and all objects with reported values for 'number of rooms' of less than one. For apartments offered for rent we exclude the highest and lowest one percent of observations for the variables 'base rent', 'square meter base rent' and 'living space' as well as the highest one percent for the variable 'number of rooms' and all objects with reported values for 'number of rooms' of less than one.

[3]For a detailed discussion of the dataset covering the years 2007 to 2013, see an de Meulen et al. (2014).

[4]We only report a subsample of the dataset, which has been used in this paper, divided into several border groups. For a description of the dataset in general with a description of all the variables, see an de Meulen et al. (2014).

by population to yield per capita values so that these variables allow for a meaningful comparison across cities with different sizes. To take a city's fiscal capacity into account, we control for the cities' actual tax revenues per capita as well as the strength of revenues from taxes.[5] All information is available at IT.NRW.

The neighborhood might have an effect on apartment prices and rents. We therefore control for neighborhood characteristics, average purchasing power per capita, the unemployment rate and the percentage of households where the head of the household has a migrant background, using a grid with an edge length of one kilometer. Information refers to the year 2010 and is obtained from microm ConsumerMarketing. We match this information to the real estate dataset via the location.[6]

4 Identification of Shocks

To estimate the causal effect of local governments' indebtedness on real estate prices we need to solve two problems. First, we need to identify shocks to governments' debt positions. Second, we need to control for potential benefits such as the supply of public goods that might be associated with an increase in public indebtedness. In the following, we therefore focus on self-governed cities in NRW. This is for different reasons. First, this region is the most densely populated area in Germany – which is a useful feature when controlling for potential positive effects of government debt[7] – that consists of different counties so that there is variation in local governments' indebtedness. Second, municipalities are the smallest government entities that are allowed to accumulate public debt and among municipalities, self-governed cities can best be compared. Third, focusing on one federal state – in our case NRW – ensures that all cities face the same debt position due to higher order government entities and the same legal framework.

4.1 Shocks to Public Indebtedness

Measuring shocks to public debt is not a trivial task. In contrast to e.g. inflation expectations there are no surveys or financial market indicators that indicate expectations of future public debt. This is of course also true for public debt on the local level. To nevertheless identify shocks to public debt we have to employ an assumption with regard to the process that generates the expected path of public debt. To check for the robustness

[5] Strength of revenues from taxes gives theoretical tax revenues assuming similar tax rates.

[6] For a description of the dataset, see Budde and Eilers (2014).

[7] The procedure we use to control for possible positive effects of an increase in public debt is introduced in Section 4.2.

of our results we employ two different assumptions: adaptive expectations and rationale expectations.

Given adaptive expectations as proposed in Ezekiel (1938), the best guess for a variable's value in the next period, in our case public indebtedness, is the current period's one.

$$E_t[D_{t+1}] = D_t \tag{1}$$

As an alternative, we follow (Muth, 1961) and assume that expected indebtedness is an unbiased estimator of ex post indebtedness

$$D_{t+1} = E_t[D_{t+1}] + v_{t+1} \ , \tag{2}$$

with the mean zero error term v_{t+1} being uncorrelated with expected indebtedness. This of course raises the question of what a good estimate for $E_t[D_{t+1}]$ is. In the forecasting literature it is well documented that AR processes are hard to outperform by adding additional predictors in terms of forecast accuracy, e.g. Rapach and Strauss (2007; 2009) or Stock and Watson (2003; 2004). We therefore stick to modeling expected indebtedness by AR-processes and check whether the those expectations satisfy the requirements $E_t[D_{t+1}]v_{t+1} = 0$ and $E_t[v_{t+1}] = 0$ to be labeled as rational.

Self-governed cities report their indebtedness subdivided into two categories, investment credit and liquidity credit (Section 3). We estimate separate panel AR-models for the logarithm of the two credit positions. In the estimation we use all 17 self-governed cities in NRW, which are directly adjacent to another self-governed city.[8] As information on the credit positions is available for the years from 1995 to 2013, we estimate the AR-model for the logarithm of investment credit for these years. For the logarithm of liquidity credit we begin the estimation in the year 2001 as liquidity credit has not been used by a considerable number of cities before this year. Taking into account the years before 2001, with the absence of liquidity credit for many cities, might be misleading as households understand that liquidity credit now is an important source of funding for local governments. Therefore, processes excluding the years before 2001 should more accurately describe households expectations.

The lag length of both AR-processes is one and is chosen according to the Schwarz information criterion (SIC). We further test for the presence of fixed effects and for ho-

[8]In detail, these are the cities Düsseldorf, Duisburg, Essen, Krefeld, Mühlheim an der Ruhr, Oberhausen, Remscheid, Solingen, Wuppertal, Köln, Leverkusen, Bottrop, Gelsenkirchen, Bochum, Dortmund, Hagen and Herne.

mogeneity in the AR-coefficients by employing Wald-tests. For both credit positions, the hypothesis of homogeneity in the AR parameter as well as a homogenous intercept has to be rejected. To test for cross sectional correlation in the error term, we employ Pesaran's test of cross sectional independence, which is recommended for cases of large number groups and a relatively small time horizon.[9] For the process of liquidity credits, we have to reject the hypothesis of cross sectional independence and therefore estimate a SUR-model with city specific fixed effects and heterogeneous coefficients for the one period lagged values. For the process of investment credits, we cannot reject the hypothesis of cross sectional independence and therefore stick to a panel-AR with fixed effects and heterogeneity in the AR coefficient. We report the estimation results in Table A.3. Checking for the correlation of the error terms v_{t+1} with the expected value $E_t[D_{t+1}]$ as well as the mean of the error term $E_t[v_{t+1}]$ implies that our forecasts indeed might be labeled as rational in the sense of (Muth, 1961).[10] Summary statistics for shocks to the two credit positions are reported in Table A.4.

4.2 Supply of Public Goods

Shocks to public indebtedness can have different effects, which depend on the driving factor. On the one hand, a collapse in tax revenues might trigger soaring indebtedness. If this collapse is due to lower tax revenues given constant tax rates, this most probably has a negative effect on real estate prices. If the collapse results from lower tax rates for households, there might as well result a positive effect on property prices as households face a lower tax burden. If, on the other hand, the increase in public debt is the result of an increase in public spending, which might have positive effects on the supply of public goods, the combined effect on property prices is unclear.

To ensure that the shock to public indebtedness is not associated with any benefits, we concentrate on border regions of adjacent self-governed cities and shocks to investment credit. As discussed in Section 3, investment credit is driven by actual government investment such as expenditures for new infrastructure.

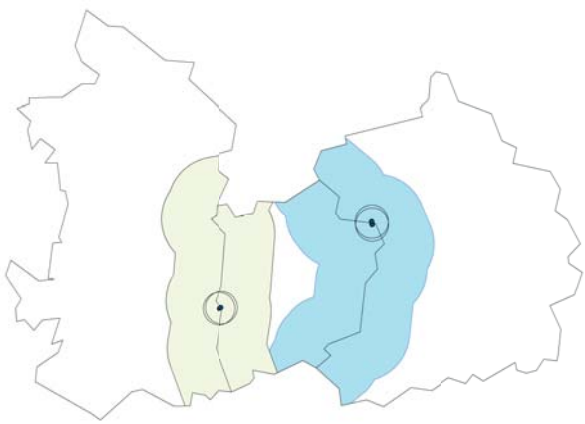
However, typical targets for such investments as transport infrastructure or cultural facilities affect real estate prices in a surrounding area, which is not necessarily in the city paying for the infrastructure improvement. Assume that there are two adjacent properties, both on different sides of a border separating two cities. It is easy to see that the relevant infrastructure for those two properties is almost identical (Figure 1). Starting from the

[9] The sample consists of 17 groups and 18 years of estimation for investment credit and 13 years for liquidity credit.

[10] Correlations and standard errors are also reported in Table A.3.

left, Figure 1 shows the self-governed cities of Duisburg, Mülheim an der Ruhr and Essen. The bands surrounding the two borders are the three kilometer buffers. The two pairs of dots represent theoretical real estate objects; circles surrounding these objects have a radius of one kilometer. Assume that one city increases its infrastructure spending at the expanse of an increase in indebtedness, e.g. to build a new tramline within its city's borders. It is easy to see that two adjacent properties should benefit equally from the improved infrastructure. However, the financial burden of such a project typically is not split between the two cities. Therefore, comparing the evolution of property prices in a border group and linking this to shocks to the investment credit position allows us to estimate the causal effect of public debt that is not associated with any benefits on real estate prices.

Figure 1: Border Groups



This identification strategy is also valid if shocks to public indebtedness are not orthogonal but correlated with other factors. Consider two adjacent cities and that there is a shock to the local economy, e.g. a shock to productivity that only affects firms in one city of the border region. This productivity slowdown affects housing prices mainly via two channels. First, it lowers employment perspectives for all individuals within commuting distance. Second, it lowers tax revenues for the city the factories with lowered productivity are located in due to lower profits, which might increase the city's indebtedness. In such a case, an unexpected increase in public indebtedness is not due to a shock to public indebtedness but driven by another variable. As adjacent properties are essentially within commuting distance to the same jobs, the productivity slowdown in

one city affects employment perspectives and therefore housing prices in both cities of the border region similarly. The increase in public indebtedness however, only affects net wealth of individuals living in the city where productivity has slowed down. Therefore, correlating the time varying housing price difference with the difference in the shocks to public indebtedness gives us the causal effect of public indebtedness on housing prices.

5 Estimation

We estimate the effect of local governments' fiscal variables on apartment prices in two specifications. In Section 5.1 we assume that apartment prices in one border group are similar and the presence of common price trend over time for all border groups. In this specification, the only drivers of price differences between cities within one border group are local governments' fiscal variables. In Section 5.2 we relax this assumption. We now allow for a group specific price trend as well as a time invariant price difference of property prices between two cities within one border group.

As we are looking at a closely populated region with a cluster of self-governed cities, some apartments are included in more than one border group given each border group entails all apartments within a certain threshold distance to the border with another self-governed city. To avoid complications from including observations multiple times, we include each apartment only once, in the border group where the distance to the border is closest.

5.1 Assuming a Common Trend

Assuming that the level of infrastructure is similar for apartments in the same border region, we can estimate the causal effect of public debt on housing prices by estimating the equation

$$P_{i,g,c,t} = \alpha_z Z_{i,g,c,t} + \alpha_t + \alpha_g + \alpha_f F_{g,c,t} + \varepsilon_{i,g,c,t} \ . \tag{3}$$

The variable P represents information on square meter prices or square meter rental

prices. Z contains object specific[11] and neighborhood[12] characteristics, F represents information on fiscal variables of the city the apartment is located in. This includes the two shocks to the cities' investment and liquidity credit positions as introduced in Section 4.1 as well as the cities' actual tax revenues and the strength of revenues from taxes, all in per capita terms. As we expect fiscal variables to affect apartment prices in absolute terms, e.g. an increase in debt of 1 Euro lowers apartment prices by X Euro, we do not employ a logarithmic transformation for the fiscal variables.[13] i, g, c and t identify in order the object, the border group[14], the city within a border group and the year of observation. The coefficients α represent the price of the respective characteristic, the time and border group fixed effects are α_t and α_g. ε is the error term, which is clustered on the city level.

5.2 Assuming a Border Group Specific Time Trend

In a next step, we employ a more flexible approach and relax the assumption of a similar price trend over time in all border regions in favor of a similar price trend within one border region. Additionally to that, we allow prices to vary within each border group.

We implement this by first, assuming that there might be a discontinuity in apartment prices at the border. Reasons for this might be that the government is able to supply public goods that are not financed by investment credit and bound to the place of residence. One example of this might be a difference in cost recovery for rubbish collection.

Second, we relax the assumption of identical infrastructure within each border group. To take into account that the surrounding infrastructure an apartment is exposed to might be less similar to other apartments in the same border group but in the other city with increasing distance to the boundary, we include distance to the border as control

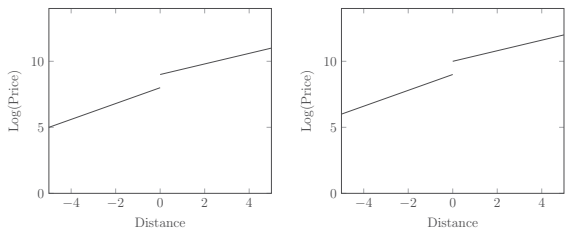
[11] In detail these are: 'living space in square meters', 'number of rooms', 'object's age', 'age^2' and 'age^3', the apartment type (10 categories: 'no information', 'top floor', 'loft', 'maisonette', 'penthouse', 'terrace flat', 'floor apartment', 'mezzanine' and 'basement'; reference category is 'apartment'), the apartment condition (9 categories: 'no information', 'first occupation', 'as new', 'renovated', 'in need for renovation', 'modernized', 'first occupancy after modernization', 'redeveloped'; reference category is 'cared'), whether there is an elevator, a garden, a balcony or a built in kitchen (each variable with the characteristics *yes* and *no information*; reference category is *not present*) and dummy variables indicating the apartment's year of construction (10 categories: 'till 1920', '1921–1945', '1946–1950', '1951–1960', '1961–1970', '1971–1980', '1981–1990', '1991–1995', '1996–2005'; reference category is '2006–not built yet').

[12] Neighborhood characteristics are the unemployment rate, purchasing power per capita and migration density. Information refers to the average value in the cell an apartment is located. Cells have an edge length of one kilometer.

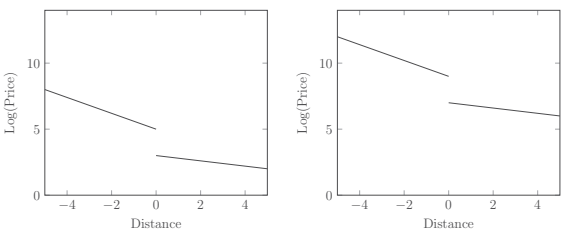
[13] Without any frictions a shock to public indebtedness should reduce inhabitants' net worth one for one. The level of debt however, should not affect price changes as would be implied given a logarithmic transformations.

[14] We build border groups consisting of objects within a threshold distance to the cities' border of two adjacent cities. As these border groups might be thought of representing one common housing market, we assume that prices in these border groups are similar.

Figure 2: Stylized Regression



(a) Group 1, $t = 1$ (b) Group 1, $t = 2$



(c) Group 2, $t = 1$ (d) Group 2, $t = 2$

variable. Distance is allowed to have a different effect for each city in each border group. To capture the causal effect of public debt, we estimate Equation (4).

$$P_{i,g,c,t} = \alpha_z Z_{i,g,c,t} + \alpha_{g,t} + \alpha_{c|c=2} + \alpha_f F_{g,c,t} + \alpha_d D_{i,g,c,t} + \varepsilon_{i,g,c,t} \ . \tag{4}$$

The variables P, Z, and F are defined as in Equation (3). However, we now also include the variable $D_{i,c,g,t}$, which represents the apartments distance to the border, and time fixed effects on the border group level $\alpha_{g,t}$. Instead of assuming a common time effect, time might now have a different effect in the different border groups, which represent different housing markets. $\alpha_{c|c=2}$ controls for the city within the the border group, allowing for a time invariant discontinuity in apartment prices with respect to distance to the border.

To illustrate this approach we present a stylized regression for two border groups and two years, with each diagram representing one border group in one year (Figure 2). We abstract from differences in object specific characteristics and neighborhood effects (Z) and differences in local governments' fiscal stances (F). On the x-axis we plot the distance to the border, real estate prices are on the y-axis. The discontinuity at the border is assumed to be constant over time as we abstract from differences in local governments' fiscal positions for illustrative purposes but is allowed to differ across border groups. What we are interested in is whether the discontinuity is constant over time for the different

border groups or, in case of time variation, whether this variation can be explained by local governments' fiscal variables.

6 Results

Before we estimate Equations (3) and (4) we have to set two threshold values. First, we need to set a threshold distance to the boundary apartments have to fall below to to be included in a border group and thus in the analysis. Second, as we do not want to extrapolate a price effect if there are no observations very close to the boundary we set a threshold for the minimum number of observations in both cities. This threshold refers to the number of observations within 250 meters to the border in both cities. To check for the robustness of our results we vary the two threshold values.

We also need to spend some thought on the relation between fiscal variables and real estate prices. The typical assumption is that a shock to public debt of 1 Euro lowers net worth for inhabitants by some Euro amount, e.g. 1 Euro in case of no frictions. However, hedonic price functions for real estate typically are estimated given a logarithmic transformation as estimating elasticities does seem to better fit the data.[15] We therefore present the results for both left hand side variables, square meter prices and square meter rental prices, as well as their logarithmic transformations.

The estimation results for the specification with a common price trend and a homogenous price level within a border group, as introduced in Section 5.1, are reported in Table 1 (for apartment prices) and in Table 2 (for rental prices). We vary the threshold distance between 3 km and 5 km. The threshold for the minimum number of observations within 250 m distance to the border in both cities of one border group is set to more than 50 observations in a first step. In a second step, we lower the requirement to more than 25 observations.

For apartment prices, the coefficient for shocks to the investment credit position is negative in all cases indicating that an increase in local governments' indebtedness lowers apartment prices. This supports the intuition that higher public debt lowers net worth of residents and this way should result in lower real estate prices as debt has to be paid back at some point in the future. However, the coefficient is not significant in all cases. In the estimations with square meter prices as dependent variable an increase in public indebtedness per capita that is associated with no additional benefit of 1 Euro lowers

[15] One example for an estimation of hedonic price functions using the ImmobilienScout24 data is Bauer et al. (2013).

Table 1: Estimation Results for Apartment Prices, Common Time Trend

	Square meter price[a]								Log square meter price[b]							
	Rational expectations (AR)				Adaptive expectations				Rational expectations (AR)				Adaptive expectations			
	3km		5km		3km		5km		3km		5km		3km		5km	
	> 25 obs[c]	> 50 obs[d]	> 25 obs[c]	> 50 obs[d]	> 25 obs[c]	> 50 obs[d]	> 25 obs[c]	> 50 obs[d]	> 25 obs[c]	> 50 obs[d]	> 25 obs[c]	> 50 obs[d]	> 25 obs[c]	> 50 obs[d]	> 25 obs[c]	> 50 obs[d]
Shock to Investment credit	-0.0269*	-0.0196	-0.0268	-0.0194	-0.0256***	-0.0198**	-0.0290	-0.0275	-0.0300**	-0.0225*	-0.0307*	-0.0245	-0.0255**	-0.0171***	-0.0314**	-0.0276**
	(0.0148)	(0.0151)	(0.0212)	(0.0238)	(0.0097)	(0.0082)	(0.0177)	(0.0181)	(0.0138)	(0.0116)	(0.0181)	(0.0192)	(0.0100)	(0.0065)	(0.0134)	(0.0131)
Shock to Liquidity credit	0.0122	0.0258	0.0454	0.0679	-0.0531**	-0.0781***	-0.0693**	-0.0961***	-0.0100	-0.0069	0.0225	0.0362	-0.0316	-0.0651***	-0.0389	-0.0725***
	(0.0250)	(0.0339)	(0.0344)	(0.0444)	(0.0249)	(0.0150)	(0.0331)	(0.0310)	(0.0191)	(0.0238)	(0.0260)	(0.0323)	(0.0252)	(0.0103)	(0.0280)	(0.0212)
Strength of revenues from taxes	0.2303	0.1491	0.4362	0.3747	0.3048**	0.3010*	0.5562***	0.5651***	0.2526	0.2254	0.4406	0.4565	0.2653	0.3197*	0.4975**	0.5855**
	(0.1881)	(0.2596)	(0.2716)	(0.3577)	(0.1435)	(0.1771)	(0.1843)	0,2202	(0.1957)	(0.2272)	(0.2822)	(0.3252)	(0.2032)	(0.1934)	(0.2441)	(0.2371)
Actual tax revenues	-0.2183	-0.1734	0-0.3733	-0.3371	-0.3064***	-0.3377**	-0.5160***	-0.5438***	-0.2443	-0.2553	-0.3857	-0.4231	-0.2590	-0.3542**	-0.4503**	-0.5589***
	(0.1564)	(0.2408)	(0.2289)	(0.3229)	(0.1114)	(0.1543)	(0.1431)	(0.1813)	(0.1658)	(0.2095)	(0.2367)	(0.2900)	(0.1801)	(0.1757)	(0.1983)	(0.1961)
Observations	16301	12521	21804	17583	16301	12521	21804	17583	16301	12521	21804	17583	16301	12521	21804	17583

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors clustered on the city level in parentheses. Control variables are: living space in square meters (in case of square meter prices) or log living space (in case of log square meter prices), the number of rooms, the object's age, age^2 and age^3, the apartment type (10 categories: 'no information', 'top floor', 'loft', 'maisonette', 'penthouse', 'terrace flat', 'floor apartment', 'mezzanine' and 'basement'; reference category is 'apartment'), the apartment condition (9 categories: 'no information', 'first occupation', 'as new', 'renovated', 'in need for renovation', 'modernized', 'first occupancy after modernization', 'redeveloped'; reference category is 'cared'), whether there is an elevator, a garden, a balcony or a built in kitchen (each variable with the characteristics *yes* and *no information*; reference category is *not present*) and dummy variables indicating the apartment's year of construction (10 categories: 'till 1920', '1921–1945', '1946–1950', '1951–1960', '1961–1970', '1971–1980', '1981–1990', '1991–1995', '1996–2005'; reference category is '2006–not built yet') as well as grid level information on the unemployment rate, a dummy variable if the unemployment rate is not available, the purchasing power, the percentage of households where the head of the household has a migrant background and a dummy variable if the information is not available. [a] Local governments' fiscal variables are in Euro. [b] Local governments' fiscal variables are in thousand Euros. [c] Border groups are: *Duisburg|Muelheim*, *Duisburg|Oberhausen*, *Essen|Muelheim*, *Essen|Oberhausen*, *Muelheim|Oberhausen*, *Gelsenkirchen|Bochum*, *Bochum|Dortmund* and *Bochum|Herne*. [d] Border groups are: *Duisburg|Muelheim*, *Essen|Muelheim*, *Muelheim|Oberhausen*, *Bochum|Dortmund* and *Bochum|Herne*.

Table 2: Estimation Results for Apartment Rental Prices, Common Time Trend

	Square meter rent[a]								Log square meter rent[b]							
	Rational expectations (AR)				Adaptive expectations				Rational expectations (AR)				Adaptive expectations			
	3km		5km		3km		5km		3km		5km		3km		5km	
	> 25 obs[c]	> 50 obs[d]	> 25 obs[c]	> 50 obs[d]	> 25 obs[c]	> 50 obs[d]	> 25 obs[c]	> 50 obs[d]	> 25 obs[c]	> 50 obs[d]	> 25 obs[c]	> 50 obs[d]	> 25 obs[c]	> 50 obs[d]	> 25 obs[c]	> 50 obs[d]
Shock to Investment credit	-0.0100	-0.0020	-0.0592	-0.0620	-0.0228	-0.0188	-0.0575*	-0.0598*	-0.0049	-0.0028	-0.0136	-0.0136	-0.0054	-0.0037	-0.0108*	-0.0104
	(0.0400)	(0.0760)	(0.0463)	(0.0860)	(0.0218)	(0.0222)	(0.0319)	(0.0330)	(0.0080)	(0.0144)	(0.0088)	(0.0157)	(0.0047)	(0.0051)	(0.0061)	(0.0065)
Shock to Liquidity credit	0.0659	0.0927	0.0786	0.1015	-0.0506	-0.0951	-0.0980*	-0.1450**	0.0066	0.0114	0.0069	0.0105	-0.0056	-0.0130	-0.0145	-0.0220*
	(0.0839)	(0.1666)	(0.0998)	(0.1826)	(0.0515)	(0.0623)	(0.0319)	(0.0715)	(0.0146)	(0.0284)	(0.0172)	(0.0313)	(0.0097)	(0.0114)	(0.0095)	(0.0131)
Strength of revenues from taxes	2.0881***	1.8735	2.4539***	2.2782*	2.1978***	2.1328**	2.5433***	2.4627***	0.4014***	0.3716*	0.4764***	0.4542*	0.4067***	0.3979**	0.4716***	0.4622***
	(0.6862)	(1.1550)	(0.8631)	(1.3031)	(0.5239)	(0.8732)	(0.6715)	(0.9495)	(0.1277)	(0.2084)	(0.1594)	(0.2348)	(0.1027)	(0.1600)	(0.1317)	(0.1794)
Actual tax revenues	-1.4860**	-1.4136	-1.7280**	-1.6560	-1.6419***	-1.7077**	-1.8801***	-1.8824**	-0.2868**	-0.2823	-0.3373**	-0.3327	-0.2970***	-0.3132**	-0.3410***	-0.3472**
	(0.6604)	(1.1205)	(0.7734)	(1.2176)	(0.5032)	(0.8456)	(0.5628)	(0.8541)	(0.1232)	(0.2029)	(0.1444)	(0.2206)	(0.1000)	(0.1565)	(0.1155)	(0.1654)
Observations	50470	36797	68955	52719	50470	36797	68955	52719	50470	36797	68955	52719	50470	36797	68955	52719

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors clustered on the city level in parentheses. Control variables are: living space in square meters (in case of square meter rents) or log living space (in case of log square meter rents), the number of rooms, the object's age, age^2 and age^3, the apartment type (10 categories: 'no information', 'top floor', 'loft', 'maisonette', 'penthouse', 'terrace flat', 'floor apartment', 'mezzanine' and 'basement'; reference category is 'apartment'), the apartment condition (9 categories: 'no information', 'first occupation', 'as new', 'renovated', 'in need for renovation', 'modernized', 'first occupancy after modernization', 'redeveloped'; reference category is 'cared'), whether there is an elevator, a garden, a balcony or a built in kitchen (each variable with the characteristics *yes* and *no information*; reference category is *not present*) and dummy variables indicating the apartment's year of construction (10 categories: 'till 1920', '1921–1945', '1946–1950', '1951–1960', '1961–1970', '1971–1980', '1981–1990', '1991–1995', '1996–2005'; reference category is '2006–not built yet') as well as grid level information on the unemployment rate, a dummy variable if the unemployment rate is not available, the purchasing power, the percentage of households where the head of the household has a migrant background and a dummy variable if the information is not available. [a] Local governments' fiscal variables are in Euro. [b] Local governments' fiscal variables are in thousand Euros. [c] Border groups are: *Duisburg|Muelheim*, *Duisburg|Oberhausen*, *Essen|Muelheim*, *Essen|Oberhausen*, *Muelheim|Oberhausen*, *Gelsenkirchen|Bochum*, *Bochum|Dortmund* and *Bochum|Herne*. [d] Border groups are: *Duisburg|Muelheim*, *Essen|Muelheim*, *Muelheim|Oberhausen*, *Bochum|Dortmund* and *Bochum|Herne*.

square meter prices by about 2.4 Cent[16]. Calculated at a living space of about 80 m^2, which is the average in our sample, this results in a price effect of about 1.9 Euro for the average apartment. For the estimations with logarithmic square meter prices as dependent variable the reported coefficients represent semi-elasticities. A shock to indebtedness per capita of 1000 Euro lowers apartment prices by about 2.8%. With a mean apartment price of about 104,000 Euro, as in our sample, this results in a price effect of about 2912 Euro.

For liquidity credit, the picture is mixed. While highly significant and negative in some cases, there does not seem to be any effect in other cases with the prefix even changing. One explanation for this might be that there are differences in the drivers of shocks to this credit position. A shock might result from a reduction in tax revenues, which again would result in lower net worth for inhabitants and should result in lower real estate prices. On the other hand, a shock to this credit position might as well result from additional spending for residents. As we did not control for benefits due to additional spending via liquidity credits in this approach, such shocks might as well increase real estate prices.

The prefixes of the estimated coefficients for the strength of revenues from taxes and actual tax revenues also are in line with the intuition, even though the coefficients are not significant in all cases. Higher fiscal strength per capita seems to increase apartment prices, actual higher tax income, which might have been paid for by residents due to property taxes, lowers apartment prices.

For rental prices, the picture with regard to a city's fiscal strength and actual tax payments seems to be very similar. As property taxes can be shifted from property owners to tenants if specified in the rental contract, a negative effect of tax revenues on rental prices seems intuitive. Shocks to the credit positions on the other hand do seem to be less of an issue for tenants. The effect of shocks to liquidity credit appears to be ambiguous. Shocks to investment credit lower apartments' rental prices in only 3 out of 16 cases significantly and only on the 10% level.

The results for the approach with border group specific time trend and a possible discontinuity at the boundary can be found in Tables 3 to 6. Again, we report the results for border groups with more than 25 and more than 50 observations within 250 m to the boundary. However, we restrict our analysis to the distance-threshold of 3 km. As we now assume that the infrastructure of two apartments in two different cities of one border group is similar at the boundary but becomes less similar with increasing distance to the border, we now can only include apartments that are somewhat close to the border. Therefore, we stick to the narrower threshold for the maximum distance to the boundary.

[16]This is the average coefficient for the estimations with square meter price as left hand side variable.

For apartment prices the most reliable estimates, at least in our opinion, includes the square meter price as left hand side variable as the relations between debt and property prices should not be an elasticity or a semi-elasticity. Additionally to that, households' expectations for the two credit positions should take into account that there might be some kind of process driving local governments' indebtedness. The results of the estimation taking these two things into account are reported in the first half of Table 3. We find that shocks to investment credit, which can be interpreted as shocks to public indebtedness not associated with any benefit due to our identification strategy, are highly significant and lower apartment prices in all cases. An increase in this debt position by 1 Euro lowers square meter apartment prices by about 2.2 Cent[17], which is similar to the effect of 2.4 Cent we found in the estimation using the strategy laid out in Section 5.1, and for an average apartment translates into a price reduction of about 1.8 Euro. Again, shocks to liquidity credit are highly ambiguous and insignificant. For a city's fiscal strength as well as actual tax revenues, the coefficients become insignificant in this specification. One explanation for the insignificance might be the inclusion of an individual price level for each city in each border group, which captures the time invariant component of these two variables and the coefficients therefore refer to the effect of the time varying component in the two variables, only.

Let us now check for the robustness of our results. Assuming the, at least in our opinion, less reliable adaptive expectations, local governments' credit positions in the next period will be the same as in the current year, lowers the effect as well as the significance of shocks to the investment credit position. In case of allowing for a cubic effect of distance to the boundary however, the effect still is significant on the 5% level. An increase in this debt position by 1 Euro lowers square meter apartment prices by about 1.5 Cent.

Turning to the estimations with the logarithmic transformation of square meter prices as dependent variable (Table 4) the results seem consistent to the previous estimations. In case of rational expectations the effect of shocks to investment credits are negative and significant in all cases, with one exception on the 5% level. An increase in this debt position of 1000 Euro lowers apartment prices by about 1.7%, which corresponds to a price effect for the average apartment of about 1800 Euro. For adaptive expectations, the prefix might be seen as an indication of a negative effect. However, the coefficients are not significant at conventional levels.

Let us now discuss the price effect of shocks to investment credit to apartments' rental prices. The estimation results can be found in Tables 5 and 6. In the estimations

[17] 2.2 Cent is the average coefficient for the six estimations.

Table 3: Estimation Results for Apartment Prices, Border Group Specific Time Trend

	Rational expectations (AR)						Adaptive expectations					
	> 25 obs[a]			> 50 obs[b]			> 25 obs[a]			> 50 obs[b]		
Dummy indicating border group and year	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Dummy for second city in border group	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Living space$_i$	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Distance to boundary$_{ij}$	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Distance to boundary$_{ij}^2$		YES	YES		YES	YES		YES	YES		YES	YES
Distance to boundary$_{ij}^3$			YES			YES			YES			YES
Shock to Investment credit	-0.0236***	-0.0271***	-0.0281***	-0.0163***	-0.0190***	-0.0203***	-0.0109	-0.0149*	-0.0163**	-0.0085	-0.0118*	-0.0132**
	(0.0081)	(0.0085)	(0.0083)	(0.0044)	(0.0054)	(0.0051)	(0.0076)	(0.0079)	(0.0076)	(0.0066)	(0.0065)	(0.0063)
Shock to Liquidity credit	-0.0175	-0.0180	-0.0184	0.0057	0.0041	0.0038	-0.0009	-0.0025	-0.0038	0.0089	0.0042	0.0029
	(0.0261)	(0.2604)	(0.0263)	(0.0287)	(0.0280)	(0.0283)	(0.0119)	(0.0080)	(0.0076)	(0.0120)	(0.0101)	(0.0102)
Strength of revenues from taxes	0.4306	0.4287	0.4071	0.0905	0.0571	0.0512	0.1527	0.1432	0.1207	-0.1247	-0.1594	-0.1691
	(0.4145)	(0.4215)	(0.4298)	(0.5446)	(0.5525)	(0.5617)	(0.5098)	(0.5073)	(0.5151)	(0.6395)	(0.6373)	(0.6439)
Actual tax revenues	-0.3606	-0.3664	-0.3574	-0.1106	-0.0906	-0.0948	-0.1222	-0.1213	-0.1141	0.0740	0.0914	0.0894
	(0.3296)	(0.3367)	(0.3414)	(0.4179)	(0.4246)	(0.4303)	(0.4085)	(0.4059)	(0.4107)	(0.5016)	(0.4989)	(0.5031)
Observations	16301	16301	16301	12521	12521	12521	16301	16301	16301	12521	12521	12521

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. i indicates the border group. j indicates the city in the border group. Standard errors clustered on the city level in parentheses. Local governments' fiscal variables are in Euro. Additional control variables are: object's age and age^2, the apartment type (10 categories: 'no information', 'top floor', 'loft', 'maisonette', 'penthouse', 'terrace flat', 'floor apartment', 'mezzanine' and 'basement'; reference category is 'apartment'), the apartment condition (9 categories: 'no information', 'first occupation', 'as new', 'renovated', 'in need for renovation', 'modernized', 'first occupancy after modernization', 'redeveloped'; reference category is 'cared'), whether there is an elevator, a garden, a balcony or a built in kitchen (each variable with the characteristics *yes* and *no information*; reference category is *not present*) and dummy variables indicating the apartment's year of construction (10 categories: 'till 1920', '1921–1945', '1946–1950', '1951–1960', '1961–1970', '1971–1980', '1981–1990', '1991–1995', '1996–2005'; reference category is '2006–not built yet') as well as grid level information on the unemployment rate, a dummy variable if the unemployment rate is not available, the purchasing power, the percentage of households where the head of the household has a migrant background and a dummy variable if the information is not available. [a] Border groups are: *Duisburg|Muelheim*, *Duisburg|Oberhausen*, *Essen|Muelheim*, *Essen|Oberhausen*, *Muelheim|Oberhausen*, *Gelsenkirchen|Bochum*, *Bochum|Dortmund* and *Bochum|Herne*. [b] Border groups are: *Duisburg|Muelheim*, *Essen|Muelheim*, *Muelheim|Oberhausen*, *Bochum|Dortmund* and *Bochum|Herne*.

Table 4: Estimation Rresults for Log Apartment Prices, Border Group Specific Time Trend

	Rational expectations (AR)						Adaptive expectations					
	> 25 obs[a]			> 50 obs[b]			> 25 obs[a]			> 50 obs[b]		
Dummy indicating border group and year	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Dummy for second city in border group	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Log living space$_i$	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Distance to boundary$_{ij}$	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Distance to boundary$_{ij}^2$		YES	YES		YES	YES		YES	YES		YES	YES
Distance to boundary$_{ij}^3$			YES			YES			YES			YES
Shock to Investment credit	-0.0191**	-0.0220**	-0.0224**	-0.0113*	-0.0137**	-0.0141**	-0.0080	-0.0114	-0.0122	-0.0057	-0.0086	-0.0093
	(0.0088)	(0.0093)	(0.0090)	(0.0059)	(0.0068)	(0.0064)	(0.0090)	(0.0092)	(0.0090)	(0.0068)	(0.0070)	(0.0067)
Shock to Liquidity credit	-0.0356*	-0.0361*	-0.0362	-0.0201	-0.0209	0.0213	0.0100*	0.0096**	0.0082*	0.0133	0.0100	0.0086
	(0.0212)	(0.0209)	(0.0209)	(0.0205)	(0.0200)	(0.0201)	(0.0055)	(0.0044)	(0.0044)	(0.0084)	(0.0099)	(0.0105)
Strength of revenues from taxes	0.0564	0.0744	0.0329	-0.2766	-0.2882	-0.3197	-0.2602	-0.2530	-0.2894	-0.5428	-0.5542	-0.5824
	(0.3498)	(0.3582)	(0.3608)	(0.4686)	(0.4810)	(0.4778)	(0.3653)	(0.3610)	(0.3718)	(0.4640)	(0.4639)	(0.4693)
Actual tax revenues	-0.0981	-0.1164	-0.0917	0.1541	0.1597	0.1768	0.1873	0.1776	0.1970	0.3804	0.3832	0.3966
	(0.2789)	(0.2867)	(0.2876)	(0.3528)	(0.3630)	(0.3594)	(0.2909)	(0.2867)	(0.2932)	(0.3547)	(0.3531)	(0.3560)
Observations	16301	16301	16301	12521	12521	12521	16301	16301	16301	12521	12521	12521

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. i indicates the border group. j indicates the city in the border group. Standard errors clustered on the city level in parentheses. Local governments' fiscal variables are in thousand Euros. Additional control variables are: object's age and age^2, the apartment type (10 categories: 'no information', 'top floor', 'loft', 'maisonette', 'penthouse', 'terrace flat', 'floor apartment', 'mezzanine' and 'basement'; reference category is 'apartment'), the apartment condition (9 categories: 'no information', 'first occupation', 'as new', 'renovated', 'in need for renovation', 'modernized', 'first occupancy after modernization', 'redeveloped'; reference category is 'cared'), whether there is an elevator, a garden, a balcony or a built in kitchen (each variable with the characteristics *yes* and *no information*; reference category is *not present*) and dummy variables indicating the apartment's year of construction (10 categories: 'till 1920', '1921–1945', '1946–1950', '1951–1960', '1961–1970', '1971–1980', '1981–1990', '1991–1995', '1996–2005'; reference category is '2006–not built yet') as well as grid level information on the unemployment rate, a dummy variable if the unemployment rate is not available, the purchasing power, the percentage of households where the head of the household has a migrant background and a dummy variable if the information is not available. [a] Border groups are: $Duisburg|Muelheim$, $Duisburg|Oberhausen$, $Essen|Muelheim$, $Essen|Oberhausen$, $Muelheim|Oberhausen$, $Gelsenkirchen|Bochum$, $Bochum|Dortmund$ and $Bochum|Herne$. [b] Border groups are: $Duisburg|Muelheim$, $Essen|Muelheim$, $Muelheim|Oberhausen$, $Bochum|Dortmund$ and $Bochum|Herne$.

with square meter rental prices as left hand side variable (Table 5) the coefficients for investment shocks are positive in all cases however, insignificant in most of them. Only in case of the lower threshold of more than 25 observations within 250 m and in case of adaptive expectations we find significant effects. This pattern is also found when we use log square meter rental prices as left hand side variable (Table 6).

The indication that there might be a positive effect of shocks to the investment credit position on rental prices could be interpreted that, even in the very flexible estimation where we allow for an increasing difference in infrastructure with increasing distance to the border and a discontinuity at the border, we might not have been able to control for all of the possible benefits of an increase in this debt position. Therefore, our estimates suggesting a negative effect on apartment prices might be seen as a lower bound as they rely on the assumption that all benefits of such shocks have been taken into account.

7 Conclusion

In this paper we have investigated the causal effect of government debt on apartment prices and rents using the example of self-governed cities in North Rhine-Westphalia. By identifying shocks to local governments' credit positions and by controlling for potential benefits that might be associated with shocks to local governments' investment credit position we have isolated the causal effect of public indebtedness on apartment prices.

We find that apartment prices strongly react to shocks to public debt. An increase in public debt of 1 Euro lowers the square meter apartment price by about 2.2 Cent, which translates into a decrease in the apartment price of about 1.8 Euro. In the rental market, shocks to public debt do not seem to affect prices. As tenants are more mobile than home owners, tenants might care less about the future tax burden, for which government debt is a proxy for, and more about the current one. Accordingly, rental prices seem to be somewhat decreasing in a city's tax revenues, which might be due to property owners being allowed to shift property taxes to tenants if specified in the rental contract. If there is an effect of shocks to indebtedness, the effect seems to be positive, suggesting that we might not have been able to control for all of the potential benefits that are associated with an increase in public indebtedness. This also suggests that our estimates for the negative effect for property prices might be thought of as representing a lower bound and an increase in public debt might be even more harmful for property owners.

The result of public debt having a substantial negative effect on property prices should be taken into account when local governments decide on their budget. In the presence of a large rental market as in Germany and tenants' indifference with respect to public

Table 5: Estimation Results for Apartment Rental Prices, Border Group Specific Time Trend

	Rational Expectations (AR)						Adaptive expectations					
	> 25 obs[a]			> 50 obs[b]			> 25 obs[a]			> 50 obs[b]		
Dummy indicating border group and year	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Dummy for second city in border group	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Living space$_i$	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Distance to boundary$_{ij}$	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Distance to boundary$_{ij}^2$		YES	YES		YES	YES		YES	YES		YES	YES
Distance to boundary$_{ij}^3$			YES			YES			YES			YES
Shock to Investment credit	0.0464	0.0461	0.0444	0.0108	0.0079	0.0073	0.0489**	0.0456**	0.0439**	0.0111	0.0085	0.0065
	(0.0422)	(0.0438)	(0.0445)	(0.0358)	(0.0377)	(0.0378)	(0.0225)	(0.0221)	(0.0223)	(0.0195)	(0.0212)	(0.0214)
Shock to Liquidity credit	-0.1254***	-0.1207**	-0.1245***	-0.0215	-0.0341	-0.0333	0.1645***	0.1653***	0.1785***	0.1029***	0.0980***	0.1034***
	(0.0455)	(0.0478)	(0.0470)	(0.0331)	(0.0328)	(0.0338)	(0.0391)	(0.0414)	(0.0436)	(0.0254)	(0.0252)	(0.0247)
Strength of revenues from taxes	1.4149*	1.2538	1.3210	1.4023***	1.3907***	1.4788***	0.8781	0.7476	0.7583	0.9632	0.9025	0.9888
	(0.7395)	(0.8001)	(0.8644)	(0.4782)	(0.5048)	(0.5118)	(0.9909)	(0.9902)	(1.0193)	(1.0153)	(0.9731)	(0.9817)
Actual tax revenues	-1.2478**	-1.1338*	-1.1809*	-1.4790***	-1.4773***	-1.5320***	-0.5834	-0.4990	-0.4873	-1.0496*	-1.0115*	-1.0611*
	(0.6201)	(0.6777)	(0.7186)	(0.4605)	(0.4990)	(0.5046)	(0.6765)	(0.6822)	(0.7048)	(0.5800)	(0.5475)	(0.5547)
Observations	34063	34063	34063	24426	24426	24426	34063	34063	34063	24426	24426	24426

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. i indicates the border group. j indicates the city in the border group. Standard errors clustered on the city level in parentheses. Local governments' fiscal variables are in thousand Euros. Additional control variables are: object's age and age^2, the apartment type (10 categories: 'no information', 'top floor', 'loft', 'maisonette', 'penthouse', 'terrace flat', 'floor apartment', 'mezzanine' and 'basement'; reference category is 'apartment'), the apartment condition (9 categories: 'no information', 'first occupation', 'as new', 'renovated', 'in need for renovation', 'modernized', 'first occupancy after modernization', 'redeveloped'; reference category is 'cared'), whether there is an elevator, a garden, a balcony or a built in kitchen (each variable with the characteristics *yes* and *no information*; reference category is *not present*) and dummy variables indicating the apartment's year of construction (10 categories: 'till 1920', '1921–1945', '1946–1950', '1951–1960', '1961–1970', '1971–1980', '1981–1990', '1991–1995', '1996–2005'; reference category is '2006–not built yet') as well as grid level information on the unemployment rate, a dummy variable if the unemployment rate is not available, the purchasing power, the percentage of households where the head of the household has a migrant background and a dummy variable if the information is not available. [a] Border groups are: *Duisburg|Muelheim*, *Duisburg|Oberhausen*, *Essen|Muelheim*, *Essen|Oberhausen*, *Muelheim|Oberhausen*, *Gelsenkirchen|Bochum*, *Bochum|Dortmund* and *Bochum|Herne*. [b] Border groups are: *Duisburg|Muelheim*, *Essen|Muelheim*, *Muelheim|Oberhausen*, *Bochum|Dortmund* and *Bochum|Herne*.

Table 6: Estimation Results for Log Aapartment Rental Prices, Border Group Specific Time Trend

	Rational expectations (AR)						Adaptive expectations					
	> 25 obs[a]			> 50 obs[b]			> 25 obs[a]			> 50 obs[b]		
Dummy indicating border group and year	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Dummy for second city in border group	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Log living space$_i$	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Distance to boundary$_{ij}$	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Distance to boundary$_{ij}^2$		YES	YES		YES	YES		YES	YES		YES	YES
Distance to boundary$_{ij}^3$			YES			YES			YES			YES
Shock to Investment credit	0.0094	0.0092	0.0088	0.0035	0.0029	0.0028	0.0096**	0.0089**	0.0086**	0.0026	0.0021	0.0018
	(0.0076)	(0.0078)	(0.0080)	(0.0068)	(0.0072)	(0.0072)	(0.0038)	(0.0037)	(0.0038)	(0.0039)	(0.0042)	(0.0043)
Shock to Liquidity credit	-0.0229***	-0.0224***	-0.0231***	-0.0086	-0.0033	-0.0030	0.0330***	0.0328***	0.0356***	0.0220***	0.0209***	0.0219***
	(0.0082)	(0.0083)	(0.0083)	(0.0058)	(0.0057)	(0.0060)	(0.0069)	(0.0072)	(0.0077)	(0.0039)	(0.0039)	(0.0039)
Strength of revenues from taxes	0.2004	0.1715	0.1907	0.1652	0.1587	0.1781	0.0994	0.0747	0.0809	0.1061	0.0901	0.1086
	(0.1278)	(0.1325)	(0.1520)	(0.1110)	(0.1160)	(0.1189)	(0.1739)	(0.1699)	(0.1739)	(0.1885)	(0.1795)	(0.1809)
Actual tax revenues	-0.1780*	-0.1578	-0.1715	-0.1946*	-0.1909*	-0.2039*	-0.0523	-0.0362	-0.0367	-0.1313	-0.1206	-0.1322
	(0.1064)	(0.1140)	(0.1254)	(0.1006)	(0.1072)	(0.1099)	(0.1151)	(0.1129)	(0.1162)	(0.1124)	(0.1059)	(0.1074)
Observations	34063	34063	34063	24426	24426	24426	34063	34063	34063	24426	24426	24426

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. i indicates the border group. j indicates the city in the border group. Standard errors clustered on the city level in parentheses. Local governments' fiscal variables are in thousand Euros. Additional control variables are: object's age and age^2, the apartment type (10 categories: 'no information', 'top floor', 'loft', 'maisonette', 'penthouse', 'terrace flat', 'floor apartment', 'mezzanine' and 'basement'; reference category is 'apartment'), the apartment condition (9 categories: 'no information', 'first occupation', 'as new', 'renovated', 'in need for renovation', 'modernized', 'first occupancy after modernization', 'redeveloped'; reference category is 'cared'), whether there is an elevator, a garden, a balcony or a built in kitchen (each variable with the characteristics *yes* and *no information*; reference category is *not present*) and dummy variables indicating the apartment's year of construction (10 categories: 'till 1920', '1921–1945', '1946–1950', '1951–1960', '1961–1970', '1971–1980', '1981–1990', '1991–1995', '1996–2005'; reference category is '2006–not built yet') as well as grid level information on the unemployment rate, a dummy variable if the unemployment rate is not available, the purchasing power, the percentage of households where the head of the household has a migrant background and a dummy variable if the information is not available. [a] Border groups are: *Duisburg|Muelheim*, *Duisburg|Oberhausen*, *Essen|Muelheim*, *Essen|Oberhausen*, *Muelheim|Oberhausen*, *Gelsenkirchen|Bochum*, *Bochum|Dortmund* and *Bochum|Herne*. [b] Border groups are: *Duisburg|Muelheim*, *Essen|Muelheim*, *Muelheim|Oberhausen*, *Bochum|Dortmund* and *Bochum|Herne*.

indebtedness, this might result in excessive public spending with different implications for home owners and tenants.

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A Appendix

Table A.1: Summary statistics apartments for sale within 5 km to boundary

		First City					Second City				
City	Observations	Observations	Square meter price	Distance	Investment credit	Liquidity credit	Observations	Square meter price	Distance	Investment credit	Liquidity credit
Duisburg|Muelheim	3971	1357	1522	-2285	863	3106	2614	1137	2469	990	3215
			533	1102	821	993		426	1136	64	402
Duisburg|Oberhausen	3246	1250	1199	-1292	1479	6324	1996	871	2454	986	3250
			449	795	99	743		357	1143	63	378
Essen|Muelheim	8818	1610	1448	-2101	836	3072	7208	1366	2503	1699	3410
			514	1091	810	994		568	1214	82	463
Essen|Oberhausen	826	329	1075	-988	1477	6336	497	1071	658	1712	3331
			414	662	100	753		354	390	79	479
Muelheim|Oberhausen	1958	1123	1161	-854	1464	6435	835	1227	1535	710	2998
			511	507	100	748		487	1272	742	903
Gelsenkirchen|Bochum	905	651	1116	-1120	2455	1351	254	914	1061	1441	1839
			437	788	97	405		331	642	93	875
Bochum|Dortmund	2715	1743	1132	-2310	1503	1903	972	1302	2038	2454	1330
			354	1732	72	389		399	1376	98	389
Bochum|Herne	3707	1861	1070	-1965	1135	2397	1846	1225	2432	2465	1302
			397	1162	35	507		476	1539	102	373

Note: Variable mean, standard deviation underneath.

Table A.2: Summary statistics apartments for rent within 5 km to boundary

		First City					Second City				
City	Observations	Observations	Square meter rent	Distance	Investment credit	Liquidity credit	Observations	Square meter rent	Distance	Investment credit	Liquidity credit
Duisburg|Muelheim	17687	4441	6.11	-2292	936	3221	13246	5.40	2781	975	3305
			1.13	1016	845	986		0.94	1063	64	364
Duisburg|Oberhausen	17680	3917	5.33	-1326	1464	6434	13763	4.80	2415	979	3280
			0.90	776	99	744		0.68	1225	64	376
Essen|Muelheim	42475	7907	5.67	-2024	926	3209	34568	5.98	2419	1684	3494
			0.98	1055	841	983		1.09	1191	83	453
Essen|Oberhausen	3667	1567	5.10	-1013	1467	6402	2100	5.60	850	1673	3574
			0.70	663	100	766		0.87	489	79	432
Muelheim|Oberhausen	8498	3920	5.24	-992	1456	6490	4578	5.51	1652	932	3222
			0.79	478	97	723		0.83	1221	845	985
Gelsenkirchen|Bochum	5195	2843	5.23	-1399	2471	1400	2352	4.79	1099	1435	1890
			0.73	1055	94	379		0.67	486	90	817
Bochum|Dortmund	10789	6830	5.18	-2566	1493	1955	3959	5.52	2013	2469	1387
			0.91	1624	74	384		0.86	1224	93	382
Bochum|Herne	19729	8670	4.99	-1658	1143	2534	11059	5.58	2695	2468	1391
			0.71	907	34	503		0.94	1385	94	386

Note: Variable mean, standard deviation underneath.

Table A.3: Shock processes for log of credit positions

	Liquidity credit		Investment credit	
	Coefficient	Std. deviation	Coefficient	Std. deviation
Wuppertal	6.0547**	2.7121	3.7948***	0.9593
Düsseldorf	3.0607***	0.3634	6.8657***	0.6568
Duisburg	6.4673**	3.1986	6.8840***	2.3784
Essen	1.3146***	0.3890	6.6092	21.9083
Krefeld	4.5439	4.2898	6.5653**	2.6404
Mülheim an der Ruhr	6.5943***	2.0697	4.5218***	1.1869
Oberhausen	6.9369**	3.3306	4.3809	10.8078
Remscheid	7.0545**	3.1771	1.346	3.7331
Solingen	6.2027***	2.2584	2.4738***	0.1795
Köln	1.5880***	0.3051	6.7421	17.6516
Leverkusen	1.8712***	0.4074	1.1947	3.5631
Bottrop	5.8668***	1.4946	3.8466	14.4988
Gelsenkirchen	1.9521***	0.3116	6.2569	8.4002
Bochum	5.3176***	1.5623	6.94	6.2987
Dortmund	1.3828***	0.4062	5.5948	12.0219
Hagen	4.4459***	1.2320	7.8337	4.8614
Herne	5.4303**	2.1299	5.235	5.8481
$E_t[D_{t+1}]v_{t+1}$	$4.82 * 10^{-9}$	0.0275	$7.35 * 10^{-9}$	0.0304
$E_t[v_{t+1}]$	$1.16 * 10^{-8}$	0.7709	$7.79 * 10^{-9}$	0.4766

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Variables in logs. City fixed effects as additional controls.

Table A.4: Summary statistics for shocks to the cities' credit positions.

	Rational expectation shock		Adaptive expectation shock	
	Investment credit	Liquidity credit	Investment credit	Liquidity credit
Mean	55.05	202.08	8.35	221.09
Median	-6.78	83.05	-22.90	207.55
Min	-528.47	-654.79	-622.92	-512.77
Max	1607.58	2040.16	1676.45	771.16
Standard deviation	262.03	408.64	236.25	228.42
Skewness	3.09	1.96	3.80	0.06
Kurtosis	15.37	8.00	28.63	3.47