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Blooming Landscapes in the West? - German reunification and the price of land.

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Abstract

German reunification was a positive market access shock for both East and West Germany. Regions that for 45 years had experienced a decline in population due to their loss in market access following the division of Germany after WWII were most strongly affected by this positive shock. We use an entirely new data set to analyse the effects of German reunification on the value of land in West Germany. We find that regions in the immediate border area experienced a relative rise in land prices compared to regions outside a 100km radius from the border. At the same time we confirm the absence of a population effect (Redding and Sturm, 2008) even including rural boroughs. We find that land values have adjusted more quickly than population and in some cases even overshot predicted long-run levels within the first decade of reunification. We attribute this finding to the information and expectation component of land prices. Land values incorporate expectations about long-run equilibrium adjustments following reunification more swiftly, but firms and households are slower to react due to the costs of relocating. The results are consistent with empirical work on the positive effects of infrastructure projects on land values (Yiu and Wong, 2005; Lai et al., 2007; Duncan, 2011).

Keywords: Economic Integration; Economic History; Regional Economics; Real Estate Markets.

JEL Classification Numbers: F15, N14, N94, R12, R30.

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1 Introduction

Germany reunified in 1990 following 45 years of different policy regimes. History offers a natural setting to empirically test the effects of this exogenous shock to market access for West Germany. Market access changed exogenously, but the policy regime remained stable in the West. This allows us to study market access as the driver of land value changes.

We find that regions in the immediate border area experienced a relative rise in land prices compared to regions outside a 100km radius from the border. This finding is consistent with the theoretical predictions from the literature, although we do not find the forecasted relative population growth in the border area. We attribute this to the information and expectation content of land values. In the spirit of an asset pricing model for land values prices adjust more rapidly to a change in relative location than population levels because prices contain expectations about future migration patterns.

The title of this paper refers to a speech delivered by chancellor Helmut Kohl on 1 July 1990 (Kohl, 1990) in which the term *Blooming landscapes* originally refers to the former German Democratic Republic. We however study the effects on the West German border boroughs which experienced their own gradual decline since division.

What are the reasons behind the differences in population density and land prices across regions? Do shocks play out similarly everywhere? Do (temporary) shocks to market access and policy regimes lead to new spatial equilibria? How are the gains from reunification distributed? Is the effect of reunification the mirror image of division? Do land values and population levels co-move? Do land values evolve similarly across Germany? What are the drivers of house price growth? And are any effects persistent in the long run? These questions will guide the following analysis.

This paper attempts to shed light on the importance of history and path dependence for the location of economic activity. It relates to the theoretical literature on new economic geography and the existence of multiple equilibria and offers a new piece of evidence for the empirical relevance of this theory. We exploit variation in the intensity of the market access shock to analyse the different outcomes in land price changes. The size of the market access shock was such that the smallest boroughs experienced a market access increase equivalent to a 15-fold population increase.

General equilibrium economic geography models centre around the question how economic activity is distributed spatially. Two effects work in opposite directions. Positive effects from agglomeration that manifest themselves in knowledge spillovers for firms, deeper consumer markets and shorter transport ways are balanced out by negative effects from congestion.

Immobile farmers and mobile industry workers result in Krugman's (1991) endogenous differentiation into core and periphery. Helpman (1998) substitutes farmers with the factor land, a view now widely shared and employed in this dissertation. The fixed supply of land is the limiting factor in preventing all economic activity from concentrating in a single location. In addition, pollution, noise or rising crime rates are forces preventing all economic activity from concentrating in one area. As a region becomes more densely populated demand for housing rises and consequently the fraction of income disposable for consumption falls. Due to the challenge of measuring the two forces economic geography models often do not disentangle the agglomeration and congestion effect and focus instead on population changes as a net measure of the two opposing forces.

Likewise trade theory suggests that market access is a crucial driver of economic development. Industries featuring increasing returns to scale or a greater reliance on supply chains tend to locate in regions with better markets access. The reunification of Germany constitutes a natural experiment to analyse the effects of an exogenous change to market access. The new data set allow us to consider the strength of these opposing forces. We exploit this relationship in considering the value of land which is the underlying fundamental of house prices.

Thereby, we are able to demonstrate that reunification led to a rise both in the level of land values and in the growth rates. The disaggregate data show that the gains from reunification are not evenly distributed. Regions closer to the former GDR experienced a relatively larger rise in land prices. Furthermore, rural areas in the border area did relatively better than cities. This is because the reunification shock was in relative terms larger for them as their own market potential is smaller.

Reunification allows us to identify the market access shock without the concern of endogeneity issues usually associated with empirical studies that consider more gradual trade liberalisations. Several approaches have been employed to overcome this issue by exploiting variation in market access such as Amiti and Javorcik (2008) who consider firm location choice in China or Trefler (2004) assessing the shock of the NAFTA free trade agreement between Canada and the U.S. These liberalisations tend to be incremental such as in the case of the NAFTA agreement between Canada and the U.S. that was preceded by a perioded of some trade activity and lengthy negotation rounds.

In line with Donaldson and Hornbeck (2016) we rewrite the Redding and Sturm (2008) version of the Helpman (1998) model. This enables us to consider land values as the dependent variable. Using a unique new data set on disaggregate land values we present an empirical analysis of the reunification effects. We do find evidence that distance to border plays an important role in understanding the dynamics after reunification. A newly assembled data set on land values (*Bodenrichtwerte*) in the four federal states along the inner German border (Schleswig-Holstein, Lower Saxony, Hesse and Bavaria) is used to assess the impact of reunification on land values.

This paper exploits the exogenous variation in market access in a difference-in-differences setup. Reunification did have a positive effect on the value of land. This effect did however differ greatly between the considered subgroups. The separate consideration of distance to border and the classification into rural and urban boroughs matters. Arguing that population levels are slower to adjust while land prices react more quickly to expectations, We offer an explanation for the fact that Redding and Sturm document a large negative division effect, but did not find a corresponding reunification effect. The theoretical predictions from the Helpman model are confirmed more convincingly with regard to land values. The cost of relocation of firms and households pose a hurdle to a speedy response of population levels.

The theoretical connection between market access and land values is clear. The empirical work has focused in particular on the link of land values and transport connections. Studies have documented positive changes in land values corresponding to announced infrastructure projects. For the US and Hong Kong these price changes are incorporated into land values well before the completion of the infrastructure improvements (Yiu and Wong, 2005; Lai et al., 2007; Duncan, 2011).

But let us first briefly turn to the historical context. Disagreement amongst the allied nations about the setup of post-war Germany ultimately led to the division of Germany into East and West. The three Western allies France, the United Kingdom and the United States of America promoted an integration of West Germany into the Western hemisphere, but the Sowjet Union kept a firm grip over the Eastern territories that would later become the German Democratic Republic. The economic and political collapse triggered the break-up of the Sowjet Union 45 years later and brought about the peaceful reunification of Germany. When the GDR elites celebrated the 40th anniversary on 7 Oktober 1989 little did they expect the events that were about to unfold. Only a month later, following mass protests around the GDR, a press conference unintenionally made the border permeable. Within a further eleven months the two Germanies were reunified. Reunification was arguably unexpected and occurred rapidly, thereby satisfying the conditions for an exogenous shock.

In reaction to the division of Germany and in particular following the construction of the wall West Germany decided to financially support the periphery. The government aid to border regions was at first an unwritten practice, but the official government aid border regions act (*Zonenrandgebietsfoerderungsgesetz*) was put into effect in 1971 by the German parliament (Bundestag, 1971). Military considerations did play a role when the decision to keep the border periphery populated was taken. The subsidies comprised a wide range of measures such as preferential treatment of companies located in the designated regions in the awarding of public contracts, tax breaks for firms as well as favourable depreciation options. In addition, social housing schemes were put in place and spending on infrastructure projects increased. This subsidy started to phase out following reunification due to the necessity to rebuild the East of Germany. Most subsidies had ceased to be granted by 1994. In this context the data allows me to consider the persistence of these subsidies.

The paper is organised as follows. After a brief presentation of the Helpman model we simulate the effect of reunification on population levels and land values. We derive two predictions that we then take to the data. In line with Redding and Sturm we do not find evidence for a systematically different population growth between the border region and the non-border region even including all rural boroughs below 20,000 inhabitants. As the Helpman model does only make long-run predictions about the equilibrium population distribution we have collected disaggregated land price data to assess the short-run effects of the fall of the Iron Curtain and the associated change in market access. We rearrange the Helpman model equations to derive an equation with the price of the non-traded amenity as the dependent variable. In the following section 3 we present the data set of standard land values. Section 4 focuses on the empirical test of the empirical predictions. A series of robustness checks follows in section 5 before section 6 concludes.

2 Theoretical framework

In the economic geography Helpman model of general equilibrium positive effects from agglomeration and congestion effects determine the distribution of economic activity across space.

Negative dispersion forces enter in the form of a fixed supply of the non-traded amenity, which we choose to interpret as the fixed supply of land. The equilibrium population distribution is determined endogenously through perfectly mobile labour thereby equalising the real wage across all regions. We calibrate the model parameters to the pre-reunification population distribution in West Germany and East Germany separately deriving one common real wage each in the West and in the East. Simulating the opening of the border We treat the two German states as one and compute the new long-run distribution of population.

The key equation relates population levels in region i to two measures of market access, housing supply and the real wage

$$L_i = \chi \ (FMA_i)^{\frac{\mu}{\sigma(1-\mu)}} \ (CMA_i)^{\frac{\mu}{(1-\mu)(\sigma-1)}} \ H_i \tag{1}$$

where $\chi = \omega^{-1/(1-\mu)} \xi^{\mu/(1-\mu)} \frac{\mu}{1-\mu}$ is a function of the real wage and a number of constants, FMA is a measure of firm market access and CMA is a measure of consumer market access. We then proceed to calibrate the model using given parameter values from the literature for σ, μ and θ such that the observed 1988 population distribution is a solution of the long-run equilibrium price vector. Appendix 6 contains an overview of the parameter choices and the other model equations.

Let us first consider the central equation derived from the Helpman model. Densely populated areas exhibit higher price levels of the non-traded amenity H_i because the supply of land available is limited and can be treated as fixed. Even in the more rural areas the administrative procedure needed to declare a piece of land as land ready for construction (*Bauland*) is complex and requires time. At least in the short and medium run the supply of land can therefore be treated as inelastic. Now an exogenous market access shock hits the system of equations and alters the relative attractiveness of boroughs. This induces future migration flows thereby bidding up the prices in some regions.

The simulation and calibration differs from Redding and Sturm in that all boroughs are considered here as opposed to focusing on cities alone. The Helpman model predicts that smaller boroughs are disproportionately affected by the same absolute market access shock. In addition, the data suggest that the difference between rural (population $<$5,000) and cities is much larger than the within city variation Redding and Sturm consider. We use the 1988 population distribution and calibrate the other model parameters. We then simulate the new population distribution following reunification by solving the system of equations simultaneoulsy using MATLAB.

2.1 Simulation of reunification

Figure 1 depicts two maps of Germany. Figure 1a shows the calibrated price levels of the non-traded amenity in West and East Germany prior to reunification. We interpret the population distribution of 1988 as the given long-run equilibrium and calibrate the model parameters such that the real wage is equalised across all boroughs. West and East are treated as two separate countries with no population movement between them. Dark blue indicates the smallest land price level while dark red signifies the highest values.

The agglomeration effects are particularly visible in the Rhein-Ruhr area, in the Rhein-Main region around Frankfurt and in the greater Stuttgart area. The wage equalisation yields a lower real wage for East Germany. The border is visible almost through the entire border stretch as it runs between the darker blue shaded areas in the East and the lighter areas in the West. This is in part explained by the different overall population sizes. The higher overall population in the West leads to a higher real wage ceteris paribus. This in turn raises the price level for the non-traded amenity. The border between East and West visible in the price level should therefore not be overstated.

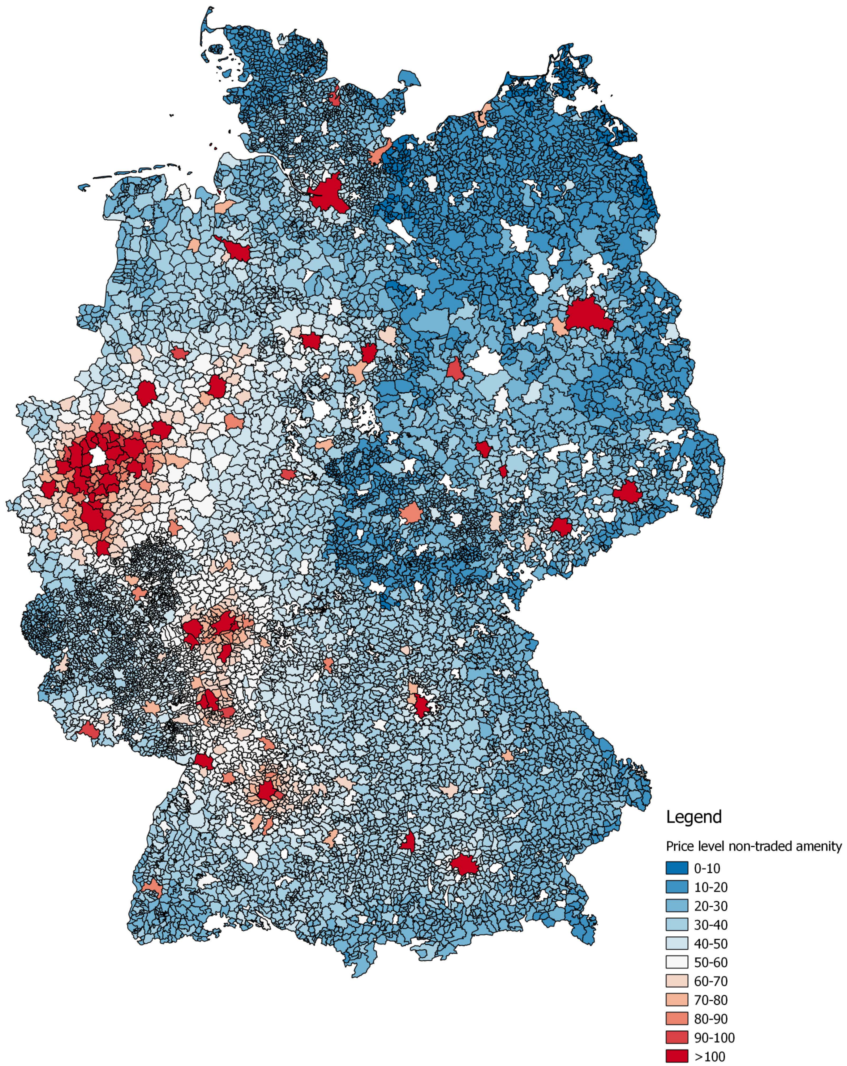
The major cities exhibit the highest price levels of the non-traded amenity. The maps derived from the model predictions confirm the observed population data: land prices are highest in the biggest cities. Agglomerations such as the Ruhr area and the greater Frankfurt region emerge.

Now simulating the opening of the border people move around and across the border to generate a new spatial population distribution equilibrium. The common real wage is now the same across East and West Germany. Comparing figures 1a and 1b we observe an apparent gravitation towards the centre of Germany. Preserving the stylised city-rural differences the East-West gap disappears.

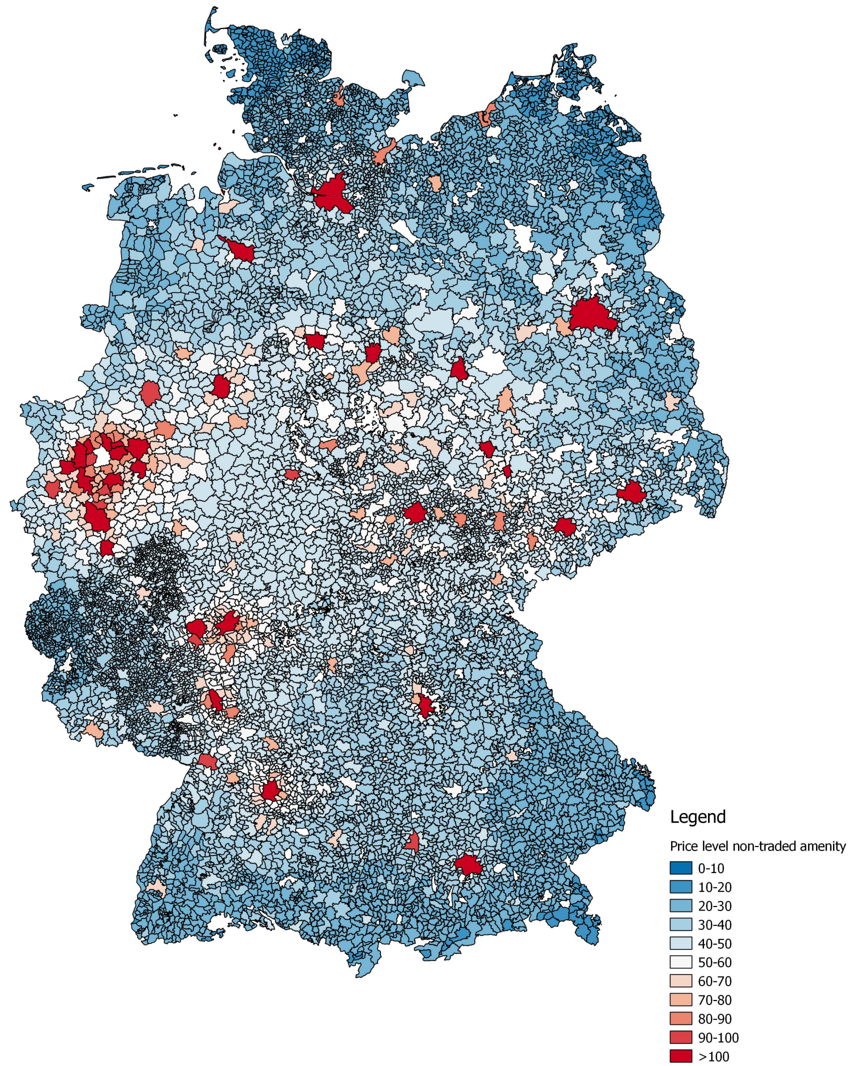
2.2 Theoretical predictions

The simulation of the market access shock from reunification on the model parameters allows us to formulate two theoretical predictions

1. Regions closer to the German-German border experience a positive population growth. The effects declines monotonically as one moves away from the border.



(a) Calibration pre-reunification



(b) Simulation post-reunification

Figure 1: Simulation Helpman model: land value equilibrium

(a) (b)

Figure 2: Simulation Helpman model: reunification

2. A positive shock to a location's market access affects locations with a smaller population relatively more as the shock is larger relative to their own market potential.

These two predictions are summarised in figures 2a and 2b. The predicted overall long-run land value growth is close to 25% in the immediate border vicinity (0–25km). The effect then monotonically decreases with the mean land value growth in the group further than 100km away from the border being negative. We exploit this reversal in the empirical section and declare all boroughs within 100km of the border to be part of the treatment group whereas the boroughs outside 100km from the inner German border form the control group. The split between rural areas and cities confirms the second prediction. The market access shock of the border opening has a relatively larger effect on boroughs with a smaller initial population. The actual values in the simulation appear like prices, but cannot be easily interpreted in their magnitude. Depending on the choice of other parameter values one can arbitrarily obtain other values. Only the relative percentage changes matter.

As transport costs in the model are approximated by distances between boroughs, the area in the centre of the unified Germany becomes more attractive. We assume that travel links do exist, are available for use from day one of reunification, and travel times are identical across regions for the same distance.

We then proceed to test the predictions in section 4 using the new data on land values. But first, we revisit the empirical exercise from Redding and Sturm to understand why they do not find empirical support for a positive reunification effect.

2.3 Reunification and relocation

Redding and Sturm do not find a significant effect of reunification on population growth in the border area. They consider only cities. We replicate their baseline estimation here using population figures for all boroughs. The Helpman model detailed in the previous section predicts a larger effect on rural areas. Only including cities in their data, Redding and Sturm may have understated the effect of reunification. Table 1 shows the results of the baseline regressions. We find confirmation of their results. The interaction term of border area and reunification in column (1) is not significant suggesting that the population growth is not systematically different in the border and the non-border area following reunification. The same applies to the border and year interactions in column (2), the time interactions do not produce a coherent picture. In column (3) we split the border area into 25km pockets. Again no clear direction emerges, in particular as the only significant coefficient of the 50–75km bracket sums to virtually zero when compared to the base coefficient without time interaction. In columns (4) and (5) we divide the sample into cities and rural areas. The coefficients of the border dummy suggest that cities within the border area experience a slower population growth than cities in the control group prior to reunification. But the same does not hold for rural areas.

Why do the Helpman model predictions differ from the actually observed population changes in the data? The possible explanations are related to the setup of the model. The key feature of the model is that its predictions concern the long run. Secondly, and similar to the division case, the long run equilibrium may not have been attained within a decade of reunification. Relocating from one area to another may take more than a few years. At the same time other variables in the model may adjust more quickly in the data. In particular the price of the non-traded amenity, which mainly captures the price of housing, may react more immediately as it entails expectations about the new long-run equilibrium spatial population distribution. The location of areas that were previously at the easternmost end of the Western world improved over night to the centre of Germany and Europe. This fundamental change in market access for these locations would, if the economic geography theory of market access and the Helpman model are correct, have to translate into higher population and higher price levels of the non-traded amenity.

But the long-run nature of these forces means that population figures may not be the most suitable variable when studying short-run effects. Ideally, one would find leading indicators such as firm or consumer confidence indices or granted construction permits. These do however not

Table 1: Baseline regressions population growth

	Population growth				
	(1)	(2)	(3)	(4)	(5)
	All	All	All	Cities	Rural
Border x reunification	0.0296			0.0416	0.0220
	(0.0586)			(0.0698)	(0.0839)
Border x year 1990		0.151*			
		(0.0825)			
Border x year 1992		-0.00729			
		(0.0855)			
Border x year 1994		0.0757			
		(0.105)			
Border x year 1996		-0.0249			
		(0.0805)			
Border x year 1998		0.0421			
		(0.0842)			
Border x year 2000		-0.0586			
		(0.0809)			
Border 0–25km x reunification			0.0845		
			(0.0927)		
Border 25–50km x reunification			0.156*		
			(0.0928)		
Border 50–75km x reunification			-0.200**		
			(0.0931)		
Border 75–100km x reunification			-0.0326		
			(0.0790)		
Border 0–25 km			-0.147*		
			(0.0867)		
Border 25–50 km			-0.134		
			(0.0838)		
Border 50–75 km			0.233***		
			(0.0831)		
Border 75–100 km			0.0396		
			(0.0753)		
Border	-0.0418	-0.0418		-0.197***	0.0345
	(0.0541)	(0.0541)		(0.0632)	(0.0746)
Constant	0.632***	0.677***	0.641***	0.351***	0.699***
	(0.0507)	(0.0527)	(0.0549)	(0.104)	(0.0644)
Observations	19,079	19,079	19,079	6,607	12,472
R^2	0.078	0.078	0.080	0.187	0.060
Year effects	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

exist on a disaggregate level such as boroughs and they are impossible to obtain backwards for the period 1980–2000.

Therefore, we put together a new data set on land values (*Bodenrichtwerte*). Prices of land react more quickly to market access shocks because they incorporate expectations about future demand stemming from a population relocation (Case and Shiller, 1989; Mankiw and Weil, 1989). Expectations about these future developments are realised more rapidly than actual firm and household moves. Using the asset pricing model for housing (Ayuso and Restoy, 2006) prices at time $t = 0$ entail all known information about future demand drivers. Hence when studying the short-run effects of the border opening, land values are a variable that serve as a leading indicator of a region's relative attractiveness. Ceteris paribus land prices are determined by demand and supply factors. With supply fixed at least in the short-run, an improvement in market access leads to an expectation of firms locating to those regions triggering households to move in the future. This drives up demand and hence prices.

The empirical work has focused in particular on the nexus of land values and transport links. Empirical studies have shown positive changes in land values following the announcement of infrastructure projects. For the US and Hong Kong studies show that price changes are factored into land values well before the completion of the corresponding infrastructure improvements (Yiu and Wong, 2005; Lai et al., 2007; Duncan, 2011). To take advantage of the price increases the Hong Kong government sold land in areas that were set to benefit from the construction of a tunnel under the harbour to finance the construction of the project.

2.4 Model rearrangement

Of the seven equations that are simultaneously solved to compute general equilibrium we focus only on the one equation that relates the price of the non-tradeable amenity — in our analysis we interpret this as the price of land P_i^H — to total expenditure and the fixed stock of the non-tradeable amenity.

$$P_i^H = \frac{(1-\mu)E_i}{H_i} \tag{2}$$

Rewriting $P_i^H = BRW_i$, where BRW stands for *Bodenrichtwerte* or standard land values, and substituting in first for total expenditue E_i and then for the wage w_i we obtain the expression

$$BRW_i \;=\; \frac{1-\mu}{\mu}\,\xi[FMA_i]^{1/\sigma}\,\frac{L_i}{H_i} \tag{3}$$

The housing supply H_i is treated as exogenously given and fixed. Analogous to reinterpreting the price of the non-tradeable amenity as the value of land we define the housing supply to be the area of a region i. Then the fraction $\frac{L_i}{H_i}$ is nothing but the population density χ_i of a region.

In line with Redding and Sturm we can rearrange equation 3 as to arrive at equation 4

$$log(\chi_i) = \;\alpha\; + \beta_i\; log(MA_i)\; + log(BRW_i) + \;\epsilon_i \tag{4}$$

which relates the population density of location i at time t to the regions market access and its land value. This specification is used by Redding and Sturm and will be our first reference point in the analysis of our data set.

We simplify further and use only one measure of market access combining firm and consumer market access. German reunification is a shock to market access and this shock is different in magnitude depending on a region's proximity to the inner German border. The model is a static model predicting long-run equilibrium outcomes, but we can look at first differences taking partial derivatives. In order to theoretically understand the implications of the model we thus compute the marginal change in land values with respect to a change in market access and obtain

$$\frac{\partial BRW_i}{\partial MA_i} \;=\; \frac{1-\mu}{\mu}\frac{\partial}{\partial MA_i}\,[MA_i]^{1/\sigma}\,\chi_i \tag{5}$$

which captures the first-round effect of a change in market access. Taking the logarithm yields a linear equation that is empirically tractable

$$\begin{aligned} Growth\ BRW_{i,t} \;=\; \alpha\; + \beta_{i,t}\; Growth\ (Market\ Potential)_i \\ + \; controls_{i,t} + \;\epsilon_i \end{aligned} \tag{6}$$

where growth rates are annualised first differences of a variable, α is a constant and β the coefficient of interest.

To derive the theoretical long-run equilibrium effect through the feedback effect in the system of simultaneous equations a simulation using a software programme such as MATLAB is required. The testable predictions are summarised at the beginning of section 4.

3 Data

3.1 Standard land values

Germany with its sixteen states is a federation and accordingly each federal state consists of administrative districts. Each district in turn keeps its own expert committee (*Gutachterausschuss*) which collects the notarial records of land transactions in their district. On the basis of these market transactions the expert committees set a standard land value expressed as a per square meter price for every borough in their district. A more detailed account on the nature of the expert committees can be found in Kleiber, Simon, and Weyers (2007). The standard land values are hence based on current market values (*Verkehrswerte*). The standard land value is the reference value for the sale of public property, the taxation of land or the calculation of inheritance tax. The standard land values are computed every two years. The expert committees consist of a chairperson and independent experts from backgrounds such as construction, architecture or engineering.

In Lower Saxony a central expert committee provided the relevant land values. In Schleswig-Holstein, Hesse and Bavaria each expert committee was contacted individually. For data protection reasons the data on individual transaction purchasing prices were not attainable. Instead the expert committees determine the land values on the basis of all transaction records from the previous two year interval. We digitised the obtained paper copies. In the presence of several land values per borough per year we computed the median value. To obtain a fully balanced sample the period 1980–2000 was divided into three subperiods. The first period t_1 (01.01.1980–31.12.1988), the second period t_2 (01.01.1989–31.12.1992), and period t_3 (01.01.1993–31.12.2000).

Table 2 presents descriptive statistics of standard land values grouped by state and time period: the number of observations, the mean, the standard deviation, and the minimum and maximum values. The complete and fully balanced data set spans 11 year observations and consists of 1,533 individual municipalities including 545 cities, i.e. regions with a population larger 5,000 and 988 rural boroughs with a population smaller 5,000.

The differences in mean land values across space can be attributed to different population densities. Lower Saxony as the least densely populated state has the lowest mean standard land values across all boroughs. Hesse as the most densely populated state has the highest levels. The vast differences in mean levels can in part also be attributed to the different structure of

Table 2: Standard land values

state	N	mean	sd	min	max
	1980–1988 = t1				
Schleswig-Holstein	537	67.16	46.87	14.67	475
Lower Saxony	266	34.58	23.68	5.888	160
Hesse	367	97.26	103.5	7.188	538.8
Bavaria	792	52.09	50.22	4.583	335
	1989–1993 = t2				
Schleswig-Holstein	537	70.02	47.62	18	500
Lower Saxony	266	38.16	25.58	3.58	173.2
Hesse	367	156.3	178.7	9	887.5
Bavaria	792	73.11	76.23	3.5	555
	1994–2000 = t3				
Schleswig-Holstein	537	110.8	84.98	25	1250
Lower Saxony	266	59.06	46.26	8.039	510.4
Hesse	367	253.1	260.9	13.42	1125
Bavaria	792	114.3	124.1	9.625	788.8

the states. Frankfurt is the largest city in our sample and in particular the neighbouring areas exhibit above-mean standard land values. On the other hand we only consider the four most Northern Bavarian administrative districts thereby excluding Munich and its urban hinterland. Hamburg is not part of the sample either.

3.2 Market potential / market access

We interpret the shock from reunification as a positive shock to market access. Accordingly we disaggregate a region's market potential into three parts. Its own market potential ($market\ potential\ eigen_{i,t}$), the market potential located in West Germany and market potential associated with East German districts.

$$Market\ Potential_{i,t} = MP\ eigen_{i,t} + MP\ west_{i,t} + MP\ east_{i,t} \qquad (7)$$

We choose an alternative approach to Helpman which is similiar to Donaldson and Hornbeck (2016) who employ a more general concept of market access that does not distinguish between firm and consumer market access. Market potentials are computed on the borough level which for the considered states in West Germany includes all 1,533 West German boroughs. Market potential in district i is the sum of its own market potential and foreign market potential. The early theoretical concept of market access dates back to Harris (1954) while a more recent contribution applying a market access function to a Krugman model of economic geography can be found in Hanson (2005). The own market potential is computed as boroughs' i population divided by the distance to the centre of the borough. Likewise foreign market potential is the sum of all other district's population figures weighted by their distance from the centre of district j to the centre of borough i.

$$Market\ Potential_i = \frac{\sum_i Population_i}{Distance_i} + \frac{\sum_j Population_j}{Distance_{ij}} \tag{8}$$

Population figures are taken from the regional database of the German states (Statistische Aemter des Bundes und der Laender (2000)). Distances to the district centre are computed assuming a circle shape of the district. The formula $0.376 \times (area_i)^{1/2}$ (Head and Mayer, 2000) is used to derive the average distance to the geographic centre of a district.

An alternative approach is to use actual travel times. The data in Nitsch and Wolf (2013) are based on actual travel times between transport districts (*Verkehrsbezirke*). The drawback of this method in the present study is the shape of the transport districts. We are interested in the effect of reunification conditional on distance to the inner German border. But some transport districts do stretch from boroughs directly adjacent to the border up to 100km inland.

Figure 3 depicts distances to the inner German border for West German boroughs.

3.3 Geography and time

Figure 4 maps standard land values in the four German states Schleswig-Holstein, Lower Saxony, Hesse and Bavaria in the year 2000. The map illustrates the relatively low levels of land values along the former inner-German border. Additionally, agglomerations such as Hanover, Frankfurt or Nuremberg are clearly visible with higher land values and with a spatial effect on the neighbouring regions. Bremen and Hamburg themselves are not part of the sample, but the knock-on effect on the urban commuting regions in Schleswig-Holstein and Lower Saxony is visible.

One potential concern of the data is the heterogeneity across expert committees and across federal states. But for the econometric analysis in section 4 this problem can be tackled by including district fixed effects to control for potentially inconsistent land value computation by expert committees. The inclusion of fixed effects remedies the problem if we assume that expert committees did not alter their valuation methods systematically over time. We argue that this is a reasonable assumption given the size of the expert committees and their stability over time.

Figure 3: Distances to inner German border

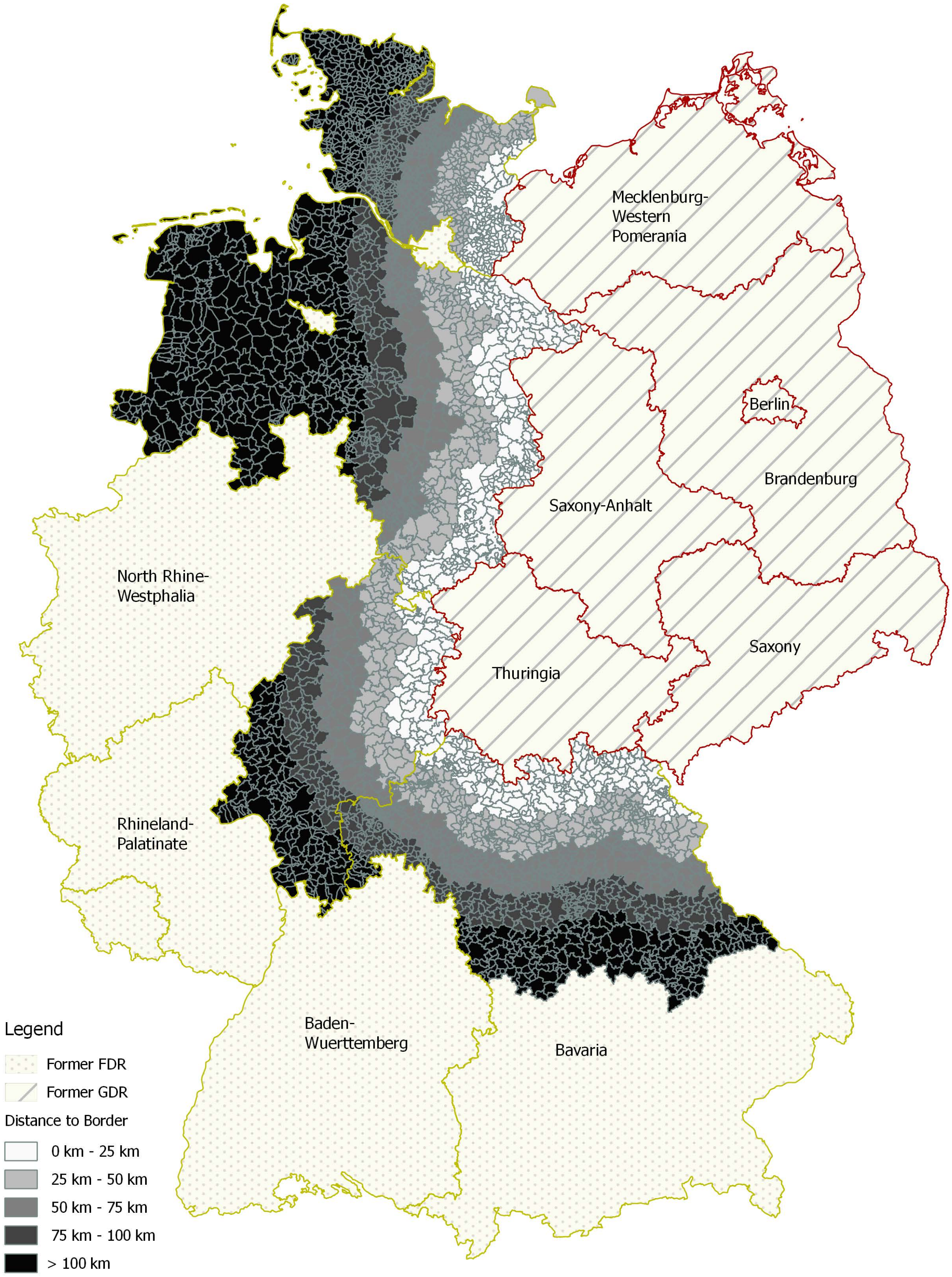
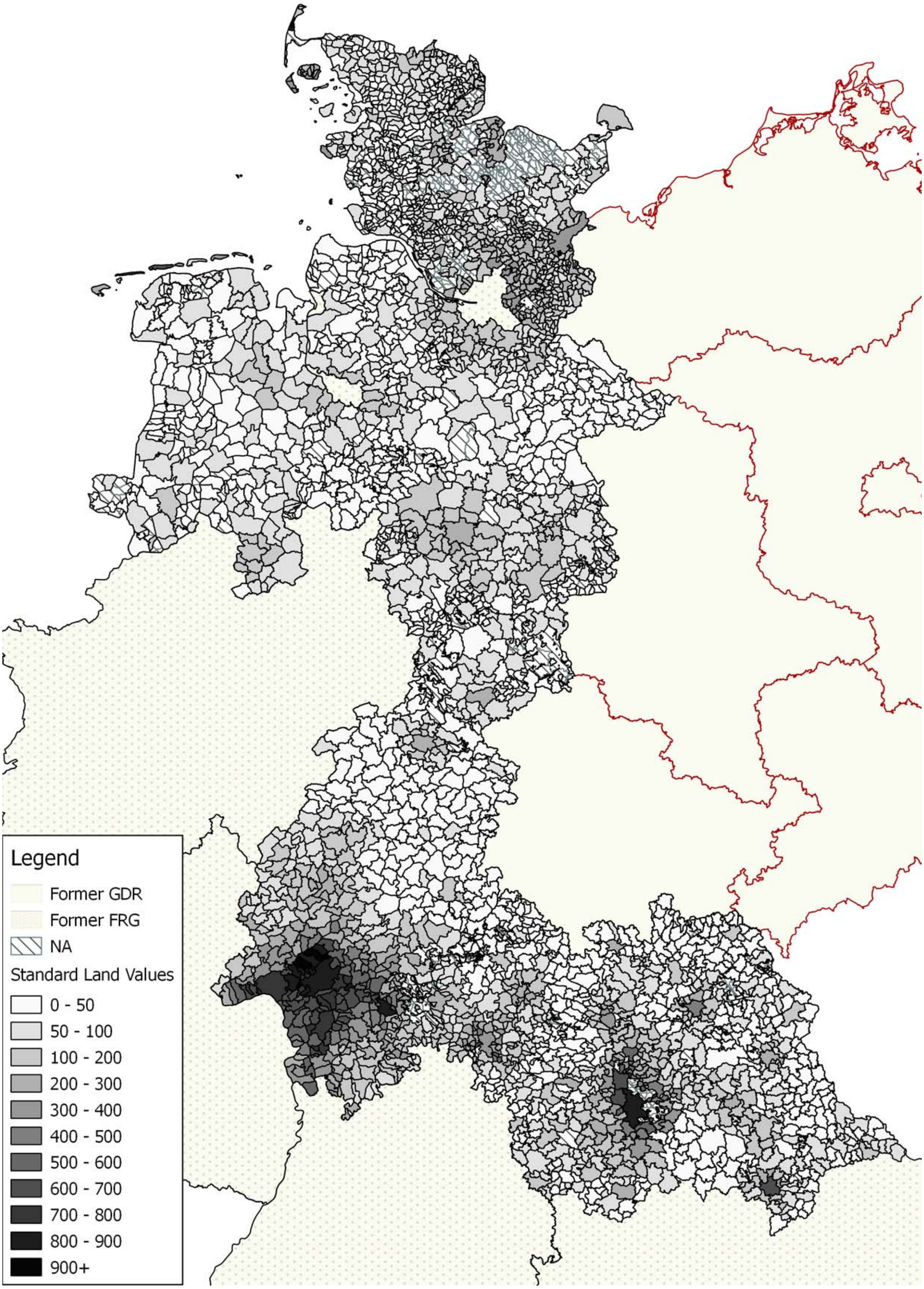


Figure 4: Standard land values in West Germany, 2000



Throughout the empirical section we use annualised growth rates for standard land values and the market potential measure.

In order to test for the effect of reunification we define the dummy:

$$reunification = \begin{cases} 0 & \text{if year} \in [1980;1988] \\ 1 & \text{if year} \in [1989;2000] \end{cases} \tag{9}$$

The date of the border opening on 9th November 1989 allows us to identify the reunification shock precisely. As land values are reported every two years the last year in the pre-reunification period 1988 captures the period 1st January 1987 to 31st December 1988. Reunification falls in the period of the 1990 observation spanning 1st January 1989 to 31st December 1990.

4 Empirical results

The empirical analysis consists of four steps. At first we run a panel analysis regression of the change in land values on a set of distance and time dummies. Finding a significant effect of reunification on land value growth rates with a difference in cities and rural boroughs, we then compare the Helpman model predictions with the observed land and population growth rates. Land values have adjusted more quickly than population levels. We deconstruct the market access variation into its three components and consider the relative as well as the absolut intensity of the market access shock. The absolute size of the market access shock stemming from the opening of the border confirms the baseline regression results, but the relative shock analysis confirms the different effects across boroughs. The last subsection of the main results section looks at the within-border variation. We confirm that smaller regions do indeed exhibit a larger response to the reunification shock than larger boroughs. It required however an initial population level to take advantage of the market access shock.

The robustness checks first establish the plausibility of the relationship in the Helpman model between land values, population and market access. The section adds to the empirical findings using distance to local markets, manufacturing employment shares and a study of the border periphery subsidy to underline the main empirical findings.

Redding and Sturm analyse the shock that German division after WWII had on city size. They find evidence that cities closer to the inner German border were more affected and that this effect diminished over time. In addition they only find a negligible effect of reunification.

In their study Redding and Sturm focus on cities with a population of 20,000 and above.

With the inclusion of all rural areas we analyse the development of land prices (*Bodenrichtwerte*) from 1980 until 2000 as one indicator for economic activity. This allows us to condition on a starting point that goes beyond a simple small city/ large city differentiation. We match these land values with other data on population, market potential and housing stock.

We follow Redding and Sturm in assuming that a stable long-run equilibrium was attained after a 45-years adjustment process starting after division in 1945.

We have derived three empirical predictions that we will proceed to test in this section 4 using our data. For the price of the non-traded amenity (i.e. the value of land) these are the analogous predictions to the population levels. They are as follows

1. The value of land in location i is positively related to the location's characteristics such as market access and population density.
2. A (positive) shock to market access results in a (positive) change in the value of land all other things equal.
3. The market acces shock from reunification affected boroughs with a smaller population more strongly.

4.1 Baseline results

Figures 5 and 6 visualise the different land price developments in the border and non-border boroughs. In figure 5 the standard land value growth index is displayed where the year 1990 is indexed at 1. The indices are computed dividing the respective annual growth rates by the average rate of change in the pre-reunification period. When comparing the two indices we notice a break around 1990, the year of reunification. The two indices developed similarly before 1990 and indeed only exhibited a small upward trend, but this upward trend accelerates after 1990. In particular the first four years until 1994 are characterised by higher growth rates, but this increase in growth rates slows down between 1994 and 2000 for both groups, the border and the non-border group. This suggestive evidence will be explored in more detail. The average borough in the sample includes both cities and rural areas and averaging over the two groups may cloud different responses to reunification.

Figure 6 displays the difference between the two indices. Corresponding to the previous figure the difference is around zero until 1990 when the difference starts widening. From 1994

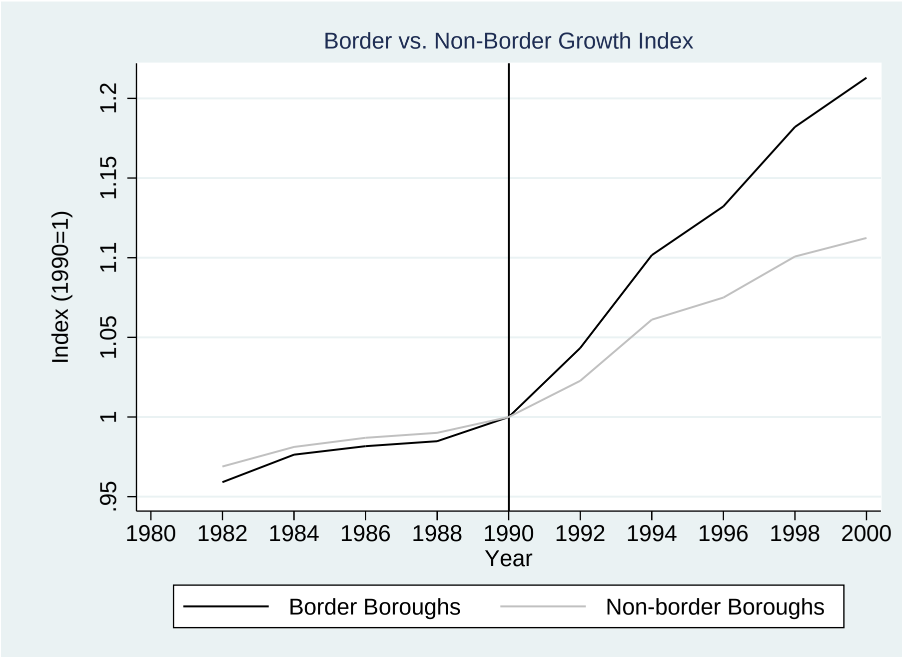


Figure 5: Border vs. Non-Border growth index

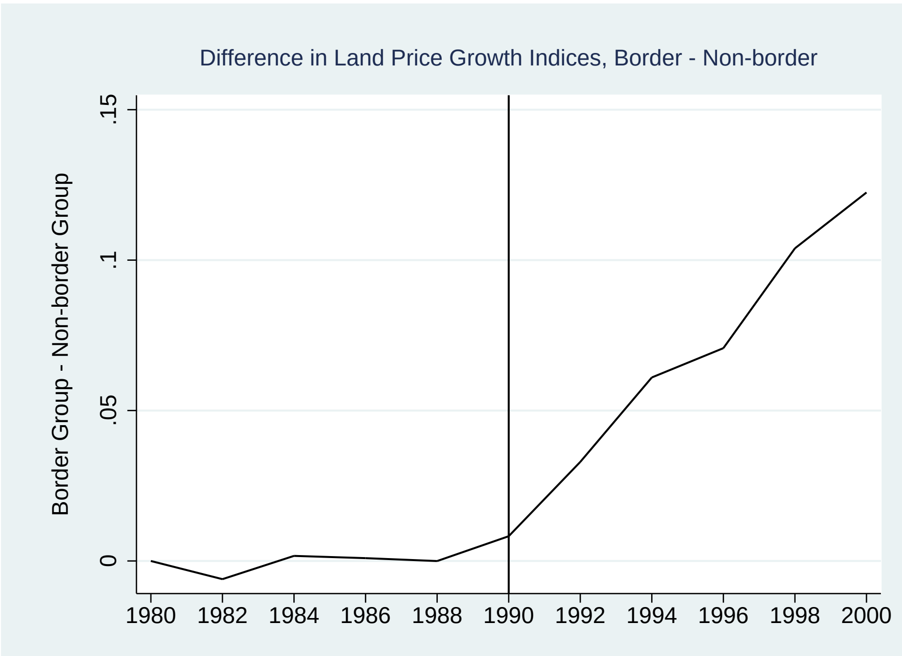


Figure 6: Difference border - non-border index

onwards the gap widens more slowly until 2000. At the end of the sample period in the year 2000 the difference between border and the non-border land value index is around 12%.

We now turn to the baseline regression equation which is restated below:

$$\begin{aligned} Growth\ BRW_{i,t} &= \beta_{i,t}(Reunification\ X\ Border) \\ &\quad +\gamma_{i,t}Border\ + controls_{i,t} +\ \epsilon_{i,t} \end{aligned} \tag{10}$$

Table 3 summarises the baseline regression results obtained from three samples. Columns (1)–(3) in table 3 display results for the full sample, columns (4)–(6) consider only cities (population>5,000), and columns (7)–(9) capture results including only boroughs with a population smaller 5,000. In all three samples three specification are run.

Regressions (1), (4) and (7) estimate the interaction effect of the reunification period with the border area. For the full sample we find a significant positive effect of reunification in the border area compared to the boroughs outside the treatment border region. Considering the effect for cities and rural areas separately yields a different picture. The effect is even larger for rural regions (column 9), but the effect is negative for cities although not significant. That is to say that the land value development of cities in the border region cannot be distinguished from the development in cities in the control group.

Columns (2), (5) and (8) display results when the reunification time dummy is split into yearly dummies. Again the coefficients of interest are the interaction coefficients of the border dummies and the time dummies. Regarding the results of the full sample it appears surprising that the only significant effect occurred in the year 2000. The other coefficients are with the exception of 1994 positive, but not significant. The reason for this finding becomes apparent when considering the split samples. Column (5) suggests that cities in the border area experienced a significant decline in land values in the years 1992 and 1996, but annualised growth rates are positive in the two years around 1998. The other year-border interactions are not significant. For rural boroughs the almost opposite effect emerges: larger and significant growth rates are found for four out of six year-border interactions. Overall the size of the coefficients declines from 1992 onwards turning even negative for 1998, albeit at a lower level of significance.

Lastly, regressions (3), (6) and (9) split up the border dummy into four 25km groups. Column (3) suggests that the effect of reunification was strongest for the treatment group in the 25–50km bin, and still positive significant for the 50–75km group at a lower level. The coefficients for the 0–25km and 75–100km are positive, but cannot be significantly distinguished from zero.

Separating again the city from the rural sample we find that the effect for the city only sample is significantly negative for cities in the immediate border vicinity in the 0–25km group. The other effects are insignificant. The rural sample yields a markedly different picture. The positive effect of reunification on land value growth rates is strongest in the 0–25km and 25–50km group. It then declines, but remains significantly positive in the other border treatment groups.

It has been shown that cities and rural boroughs exhibit a very different reaction to the reunification shock. The choice of the sample matters. Comparing cities within the border region only to cities outside the border region and likewise rural boroughs only to other rural boroughs one may neglect important features of the data hidden in the cross comparison. For that reason appendix 6 contains baseline regressions with an additional interaction variable of *Border X Reunification X City*. But the results do not yield any new insights.

The next section therefore presents a direct comparison of total cumulative land value changes in rural and city boroughs split into border and non-border boroughs. We compare this to the Helpman model predictions.

4.2 Prediction vs. realisation

Figures 7 and 8 summarise the key results from this paper. Land prices have within a decade already realised the predicted gains, but population growth has not seen the same trajectory. Land values appear to adjust more rapidly, but population levels do not.

Both figures compare predicted and in the data observed cumulative total changes in rural boroughs (figure 7) and cities (figure 8) both in terms of population growth and land value growth. Within these figures we then divide them up again into non-border boroughs and border boroughs. In total these two figures comprise sixteen aggregate data points.

Beginning with the left panel in figure 7 we observe that the model predicts a very similar long-run total growth of population and land prices. The border area is predicted to do relatively better than the non-border area. The magnitude of the predicted growth is now contrasted with the actually observed changes up until 2000. The model predicts an increase in population and land values in the non-border area of around 5%, but the data tell a different story. We measure a population decline of 6%. Despite this fall in population the land values increase by around 12%, markedly above the predicted change. The same applies to the border area. Population has grown an average of 2%, but the model predicts a long-run growth of 17%. At the same time land values have overshot their predicted total growth by 7% within a decade. We

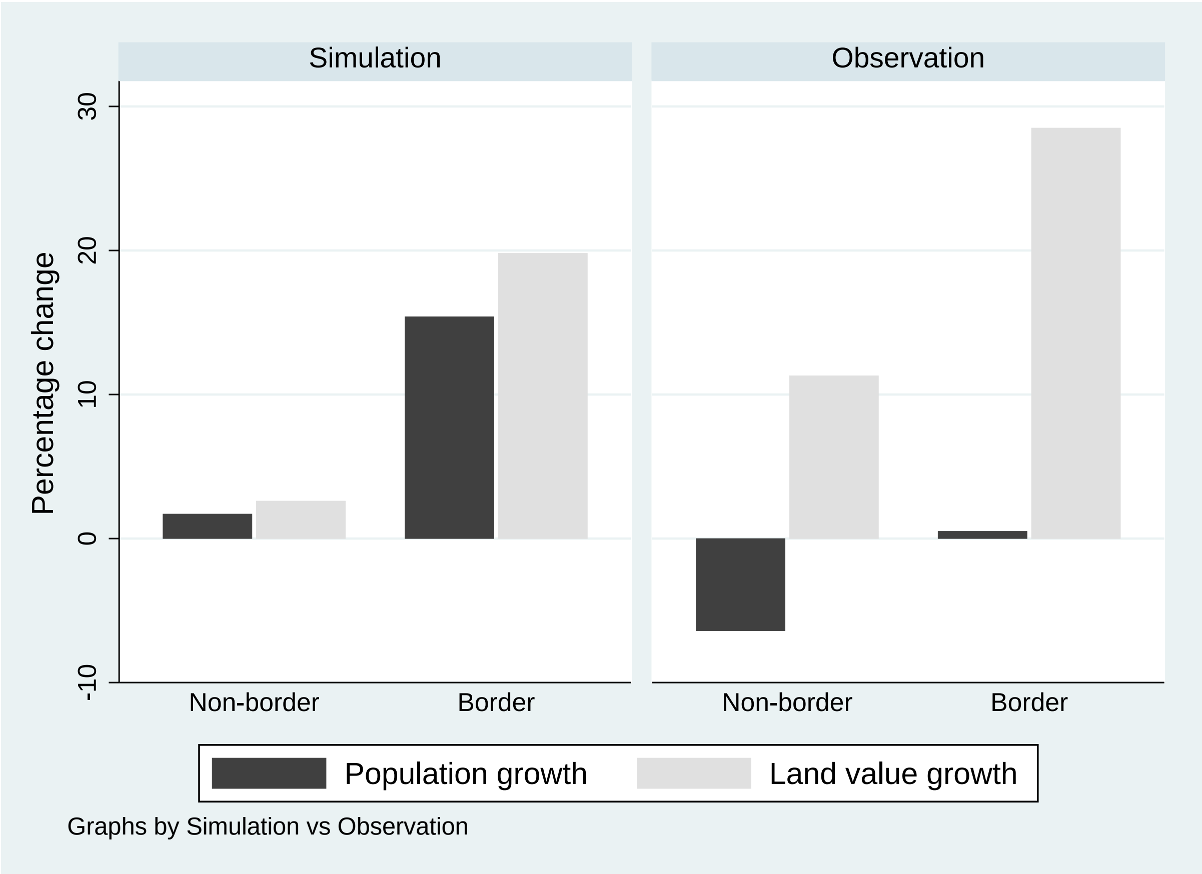
Table 3: Reunification baseline

	Land value growth								
	(1) All	(2) All	(3) All	(4) Cities	(5) Cities	(6) Cities	(7) Rural	(8) Rural	(9) Rural
Border x reunification	0.993***			-0.513			1.603***		
	(0.361)			(0.651)			(0.444)		
Border x year 1990		1.102			-0.413			2.336***	
		(0.696)			(1.502)			(0.764)	
Border x year 1992		0.931			-3.754**			3.835***	
		(0.722)			(1.495)			(0.789)	
Border x year 1994		-0.494			-1.797			0.274	
		(0.651)			(1.189)			(0.791)	
Border x year 1996		0.974			-3.327**			2.771***	
		(0.812)			(1.539)			(0.958)	
Border x year 1998		1.425			6.012***			-2.477*	
		(0.965)			(1.692)			(1.271)	
Border x year 2000		2.045***			0.268			2.472***	
		(0.548)			(0.889)			(0.713)	
Border 0–25km x reunification			0.762			-3.910***			2.679***
			(0.533)			(1.148)			(0.597)
Border 25–50km x reunification			2.612***			1.475			3.291***
			(0.591)			(0.925)			(0.770)
Border 50–75km x reunification			1.022*			-0.330			1.842***
			(0.538)			(0.933)			(0.661)
Border 75–100km x reunification			0.716			-1.121			1.938***
			(0.510)			(0.791)			(0.663)
Border 0–25 km			-2.146***			0.315			-3.182***
			(0.401)			(0.918)			(0.433)
Border 25–50 km			-1.615***			-0.331			-2.180***
			(0.426)			(0.730)			(0.527)
Border 50–75 km			-1.023**			0.0396			-1.471***
			(0.428)			(0.736)			(0.522)
Border 75–100 km			-0.952**			0.306			-1.713***
			(0.386)			(0.654)			(0.477)
Border	-1.188***	-1.188***		-0.0991	-0.107		-1.528***	-1.525***	
	(0.272)	(0.272)		(0.510)	(0.510)		(0.327)	(0.328)	
Constant	0.419	-0.114	0.576*	-1.280***	-1.550***	-1.038*	1.015***	0.536	0.957**
	(0.274)	(0.335)	(0.300)	(0.494)	(0.521)	(0.530)	(0.339)	(0.463)	(0.376)
Observations	16,863	16,863	16,863	5,995	5,995	5,995	10,868	10,868	10,868
R^2	0.036	0.036	0.038	0.042	0.050	0.047	0.039	0.043	0.041
Year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

attribute this to the evidence that prices do react much more quickly to the market access shock of reunification. They incorporate expectations about future (predicted) population movements and preempt the then induced changes to land values. In particular, the border area population has grown only a tiny bit of the predicted way, but land prices have even overshot the model predictions. The in the data observed negative population growth in the non-border area may be driven by an underlying urbanisation trend, a trend which does not feature in the Helpman model.

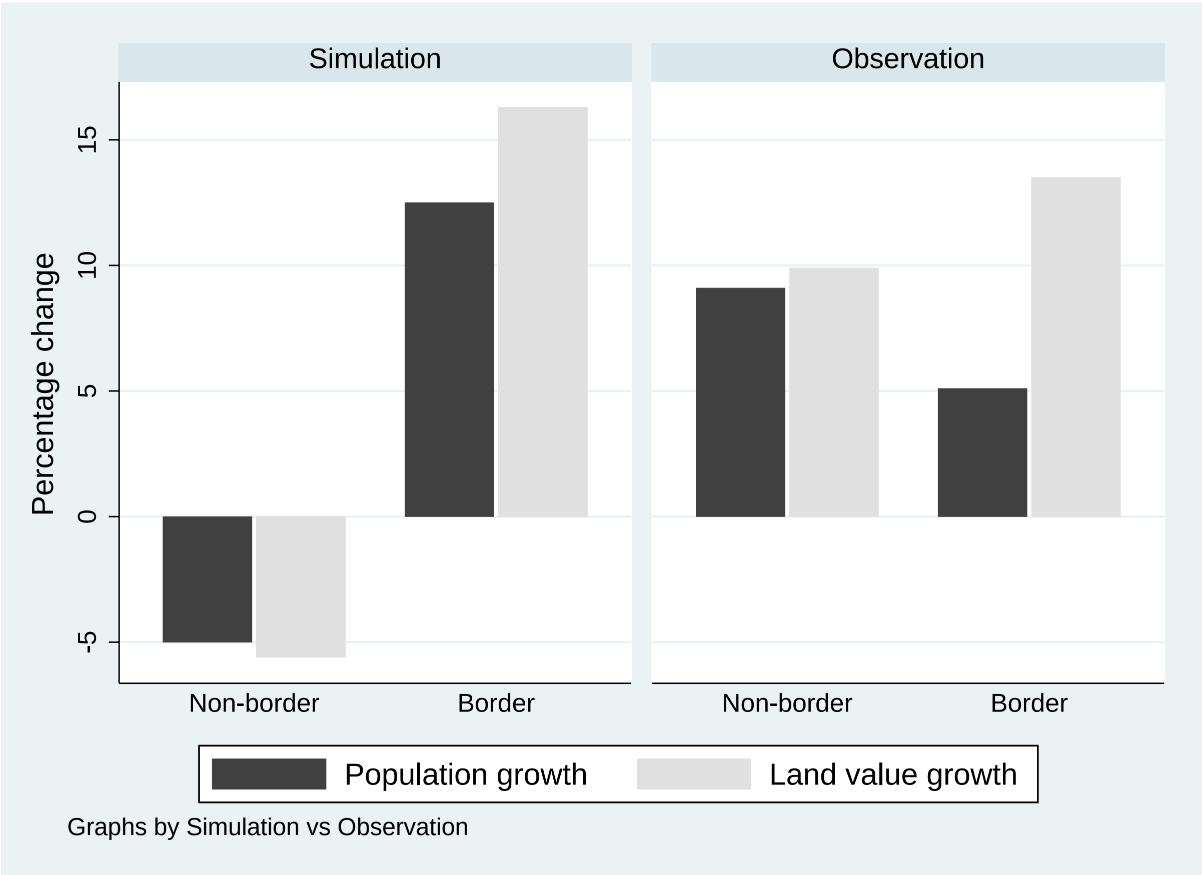
Figure 7: Rural borough growth



Turning now to the simulation panel in figure 8, city growth in the non-border was predicted to be -5% for population and land value levels. The border area cities were on average predicted to grow by 12%, and land values were predicted to go up by 16%. Again the observed growth rates paint another picture. Cities in the border and the non-border area have grown, but the non-border cities grew by an extra 3% on average. Land values in the non-border have gone up in similar magnitude to the population levels. But in the border area land values have outpaced population growth again. Population has grown only about a third of the expected way, but land prices have already adjusted 80% to the predicted level.

Apart from the information content explanation, the comparison with the rural areas may potentially hint at quicker population relocations in cities. Opposed to rural areas where adjustments happen over a longer time frame, cities react more quickly.

Figure 8: City growth



In sum, we have found confirmation of the Helpman model predictions. First, regions in the immediate border area do relatively better than the control group outside 100km of the border. Furthermore, regions with a smaller population are relatively more affected by the market access shock as their own market potential is small compared to the added market potential.

4.3 Shock intensity

In addition to the difference-in-differences analysis presented in previous subsections the reunification shock allows for an analysis that does not clearly distinguish between a treatment and a control group. This is particularly important as one might be concerned about the choice of treatment and control groups in the previous subsections.

Instead the whole sample is divided up into quintiles and assigned values 1–5. These quintiles measure two different types of shock intensity. The first one is relative shock intensity. 20% of the boroughs that experienced relatively the smallest shock are in the first quintile (Q1). Q2 then captures the 20–40% quintiles, and so forth. This measure of shock intensity is interacted with the reunification time dummy. The relative shock intensity may be challenged on the grounds that one cannot disentangle the effects caused by closer distance from the ones from a larger population.

The second measure is absolute shock intensity. This is in some ways another way to measure distance to border, but again we do not assign a clear control group. We consider two measures of the market access shock, one in absolute terms and the other in relative terms.

The coefficients of interest in columns (1)–(3) of table 4 are the interactions of the reunification time dummy with the relative market access shock quintiles. Considering all three different samples it emerges that the middle quintile interaction is always negative, even if not always significant. At the same time all other interactions are positive and apart from the city sample (where only the interaction of the first quintile is significant at 5%) all significant. We interpret this as follows: regions that received a medium intensity treatment of the market access shock — be that due to their relative size or their medium distance to the border — show the smallest reaction. All other regions exhibit a larger treatment effect which in the full sample and the rural sample specification is largest for the quintile that is relatively most affected.

It is again important to note that one cannot pinpoint at either distance or population measure to cause the quintile affinity of boroughs. Therefore, we now consider absolute shock intensity which is another way of measuring the border distance. Here boroughs in the immediate border vicinity were in absolute terms hit hardest by the reunification treatment. The advantage over the baseline specification is that there is no treatment or control group, but rather one continuous treatment group. This addresses concerns about the choice of the treatment group.

The results are displayed in columns (4)–(6). Simplifying the results one can say that the boroughs in the lowest quintile, i.e. boroughs that received the smallest absolute market access shock, did experience a negative land value growth in the reunification period. The coefficients then increase in magnitude (albeit not strictly monotonically) and are largest for the quintile that received the largest absolute shock. The coefficients are significant at the 1% level with the exception of the 2nd–4th quintile interactions in the city sample.

Overall these results confirm our findings of the baseline border specification.

Table 4: Shock intensity

	Land value growth					
	(1)	(2)	(3)	(4)	(5)	(6)
	All	Cities	Rural	All	Cities	Rural
Reunification x relative shock Q1	1.654***	1.431**	1.747**			
	(0.464)	(0.694)	(0.768)			
Reunification x relative shock Q2	1.693***	0.731	2.036***			
	(0.398)	(0.677)	(0.501)			
Reunification x relative shock Q3	-0.726*	-0.658	-0.935**			
	(0.386)	(0.736)	(0.450)			
Reunification x relative shock Q4	1.664***	1.031	2.125***			
	(0.393)	(0.780)	(0.464)			
Reunification x relative shock Q5	3.350***	0.541	4.246***			
	(0.422)	(0.871)	(0.488)			
Reunification x absolute shock Q1				-1.810***	-2.528***	-1.250**
				(0.454)	(0.905)	(0.518)
Reunification x absolute shock Q2				1.741***	0.732	2.171***
				(0.369)	(0.670)	(0.459)
Reunification x absolute shock Q3				1.323***	1.015	1.323***
				(0.373)	(0.643)	(0.465)
Reunification x absolute shock Q4				2.324***	1.427*	2.727***
				(0.410)	(0.797)	(0.474)
Reunification x absolute shock Q5				5.132***	2.700***	6.260***
				(0.460)	(0.887)	(0.534)
Relative shock intensity	-0.597***	-0.266	-0.712***			
	(0.120)	(0.214)	(0.153)			
Absolute shock intensity				-1.585***	-1.357***	-1.666***
				(0.105)	(0.234)	(0.112)
Constant	0.719	-1.189	1.348**	5.240***	4.973***	5.285***
	(0.544)	(0.973)	(0.680)	(0.382)	(0.816)	(0.408)
Observations	16,863	5,995	10,868	16,863	5,995	10,868
R^2	0.041	0.045	0.048	0.038	0.041	0.045
Year effects	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

4.4 The importance of size

After establishing a reunification treatment effect, which was stronger for the rural boroughs than for cities, we now turn to the different magnitudes of this effect. We find severe within rural borough variation of land value growth in the border group. The same applies to within city variation. Purely distinguishing between city and rural clouds this interesting feature of the data. The last figure in the subsection therefore splits the border area itself up into population deciles. The number of boroughs in each decile is the same. Figure 9 documents mean cumulative growth which was largest in boroughs in the 2nd–3rd population decile. After this decile the cumulative land price growth declines monotonically with a slight increase again at the 10th decile.

We interpret this as evidence that boroughs with a smaller population exhibit indeed a larger mean cumulative land value gain, but it required an initial level of population to benefit from the reunification shock in the same way as the 3rd decile. This can be seen as the first decile increased on average over the ten years by around 27 percent when the third decile gained an average of almost 40%. The boroughs in the third decile are relatively sparsely populated with the mean population of the third decile population 1,292.

Boroughs in the sixth decile have a mean population of 5,762 and fall in the small city category. The mean cumulative land value growth is around 27% and continues to decline further. The decile with the lowest land value growth has an average population of 12,115 inhabitants, again falling into the small city category. The 10th decile with an average population of 32,982 (and thereby a medium city) shows an average increase in land values of around 18%, somewhat higher than the 9th decile but still markedly below the border group average gain.

To sum up not only does the distinction between city / non-city and border / non-border matter, even within the border treatment group there exists heterogeneity in the land value responses to reunification.

5 Robustness checks

This section presents a number of robustness checks beginning with a plausibility check of the data in the pre-reunification period. We explore other potential drivers of land value responses such as distance to local markets, employment shares in the tradeables sector and the border periphery subsidy.

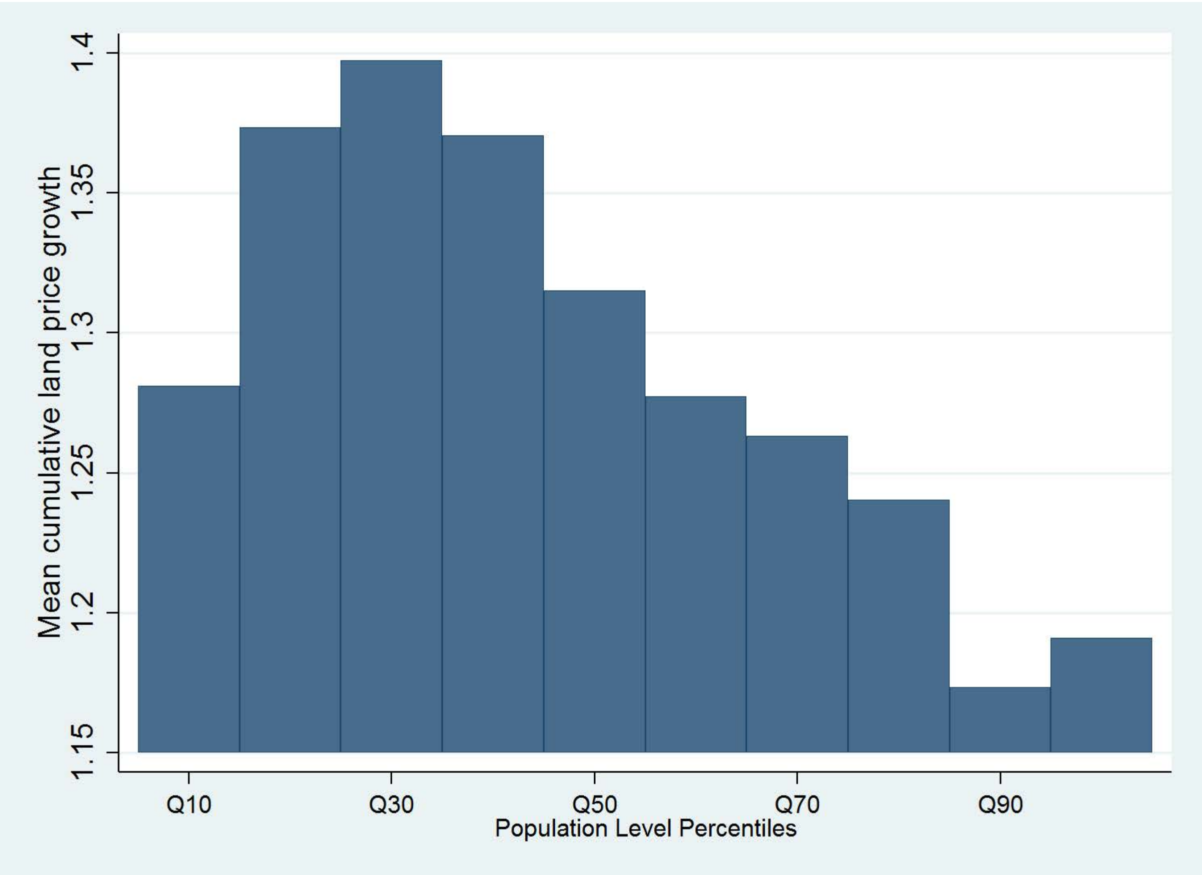


Figure 9: Growth of land prices by population deciles

5.1 Cross-section analysis

The previous sections rest on the assumption that the theoretical relationship between the land value data, the population figures and the market access variables is indeed empirically plausible. The descriptive evidence presented earlier suggest that the data match features of the observed world, but in addition we run here cross-section regressions to back up this suggestive evidence.

We begin by testing prediction 1 of the Helpman model, the relationship between population, market access and land values. We restate equation 4 for convenience and estimate three specifications

$$BRW_i = \beta \ X_i + \ controls_i + \ \epsilon_i \tag{11}$$

where X_i is replaced by population size, border groups or market potential measures depending on the specification.

The results for the estimation of the equations are displayed in table 5. Column (1) of table 5 confirms the significant effect of population levels on land values. We obtain a similar result when considering population density instead of population levels. Indeed population levels and market potential are highly significant determinants of standard land values. Likewise distance to border has a negative effect on land value levels with a declining effect in the 25km intervals. Boroughs within a 25km perimeter of the inner German border exhibit on average standard land values that are 47.43 DM lower per square meter than land values in the control group (boroughs that are at least 100km away from the border). Likewise boroughs in the 25–50km distance group from the border have land values that are on average 36.94 DM lower. The 50–75km group is not significantly different from the control group. The same applies to the 75–100km group which is not displayed here.

Turning to columns (3) and (4) we consider the correlation between market potential and land values. Column (3) confirms a highly significant correlation between the two. Disentangling the contribution of a borough's own market potential and foreign market potential it becomes apparent that a borough's own market potential has a far larger effect on land values than the foreign market potential. This holds however only in the steady pre-reunification equilibrium. As shown earlier the opening of the border translated into a multiplication of market potential of up to 15-times for some boroughs. The change in market potential comes almost entirely from the change in foreign market potential.

Table 5: Cross-section pre-reunification

	Land value level			
	(1)	(2)	(3)	(4)
	All	All	All	All
Population (in 10,000)	11.61***			
	(2.249)			
Border 0–25 km		-47.43***		
		(3.593)		
Border 25–50 km		-36.94***		
		(4.804)		
Border 50–75 km		-2.386		
		(5.332)		
Market Potential			9.600***	
			(0.627)	
Own Market Potential				41.66***
				(2.677)
Foreign Market Potential				3.183***
				(0.651)
Constant	89.73***	114.4***	-109.8***	-23.33*
	(2.844)	(3.743)	(14.38)	(13.45)
Observations	9,810	9,810	9,810	9,810
R^2	0.196	0.153	0.201	0.357
Year effects	No	No	No	No

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5.2 Distance to local markets

A further concern might be that growth in land prices is driven by proximity to local markets instead of markets further away. The change in market potential coming from a change in the immediate markets may have a larger effect on a borough's land value than a (potentially) larger change further away with missing infrastructure links. Rural areas near cities may have benefitted from their close location to larger markets, thereby being able to take advantage of export opportunities or shorter commuting times.

We test this by including the share of employment in the manufacturing sector as an instrument for capacity to benefit from a market access increase. The share of manufacturing employment is measured as the total number of people employed in the manufacturing sector divided by total population. It is of course an imperfect measure of actual employment shares as one should divide the number of manufacturing employees by the labour force instead of total population. For the considered period we were unable to obtain labour force figures on a disaggregate borough level. As employment figures are only available on a municipality level, this may give rise to ecological inference problems.

The empirical literature on international trade finds that exporting firms tend to be larger than non-exporting firms (Bernard et al., 2007; Bernard et al., 2012). We use this finding to interact the share of large firms of districts with reunification. Distance to the nearest large city is a significant driver of land value growth, but the size of the city plays a minor role. At the same time boroughs with a larger share of manufacturing employment tend to exhibit above average growth of land values following reunification. This effect does however not hold for the large firm share interaction.

The data come from the Federal Employment Agency (IAB). [1] The data is reported in six firm size categories, under 50 employees, 50–99 employees, 100–199 employees, 200–499 employees, 500–999 employees and 1,000+ employees. In case that there exist only 1 or 2 firms in a given category and a given municipality, no data are reported. To fill the missing data, we replace the blanks by the average number of employees in this category across all municipalities that report in this firm size category. We then sum up the total number of employees by municipality and compute the respective shares.

City groups are assigned according to population figures $smallcity \in [5,000; 20,000]$, $midcity \in [20,001; 100,000]$ and $largecity \in [100,001; \infty)$. Distances are computed to the respectively nearest large, medium or small city. If the nearest city is a large city, than the distance to the nearest medium or small city is identical.

The results are displayed in table 6. Column (1) reports the results from an interaction of the reunification dummy with the distance measures. It appears that distance to the nearest large city does indeed increase land value growth rates. The results do not hold for medium and small cities. This may potentially be driven by the fact that for boroughs where the nearest city is a large city the distance to the nearest medium and small city is identical.

Column (2) and (3) then report regression results where manufacturing employment shares and large firm shares are interacted with reunification. For the share of manufacturing employment we find a positive effect on land value growth. Boroughs with a larger share of manufacturing employment tend to experience larger land value growth. This effect does however not carry over to the share of large firms. This might be caused by the fact that not every large firm is an exporter.

[1] `https://statistik.arbeitsagentur.de/Navigation/Statistik/Statistik-nach-Themen/Statistik-nach-Wirtschaftszweigen/zu-den-Produkten-Nav.html` [accessed 14/02/2014]

Table 6: Local markets and manufacturing employment

	Land value growth		
	(1)	(2)	(3)
	All	All	All
Reunification x dist. large city	0.0340***		
	(0.00686)		
Reunification x dist. medium city	0.0104		
	(0.0206)		
Reunification x dist. small city	0.0578		
	(0.0415)		
Distance large city	-0.0338***		
	(0.00564)		
Distance medium city	-0.0190		
	(0.0165)		
Distance small city	-0.0475		
	(0.0324)		
Reunification x manufact.		0.797*	
		(0.430)	
Manufact. employment share		-0.750**	
		(0.290)	
Reunification x large firms			0.295
			(0.369)
Share of large firms			-0.224
			(0.344)
Constant	2.361***	2.807**	2.904***
	(0.198)	(1.095)	(1.104)
Observations	16,863	16,863	16,863
R^2	0.013	0.028	0.028
Year effects	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5.3 Border periphery subsidy

As discussed previously a number of designated administrative districts received a border periphery subsidy while others did not. We test for an interaction effect with the reunification dummy, and extend the definition of the border dummy to the border boroughs of Eastern Bavaria that were located along the border with Czechoslovakia. The reason for this is twofold. Cross-border trade between Bavaria (and the Federal Republic of Germany) and Czechoslovakia did occur following a trade agreement signed on 3 August 1967. For this reason the Bavarian districts along the Czechoslovakian border were not included into the border dummy defined for the previous specifications. But these districts did nonetheless succeed in obtaining the border periphery subsidy. They are therefore included into the border specification used in this subsection.

Column (1) of table 5 shows no statistically significant interaction. But the border subsidy level control shows the same sign as the border control coefficient in the baseline. Column (2) splits up the reunification interaction into yearly (or period) interactions. The interaction of the border subsidy and the year 1994 is strongly negative and significant. As the border subsidy phased out between the years 1992 and 1994 this is evidence of the withdrawal. The then following interactions are positive and with the exception of 1998 significant. This is in line with the findings from the baseline (table 3). It may also help in understanding why in the baseline specification the early years of reunification are not characterised by significant land value growth rates. The phasing out of the subsidy worked in the opposite direction of the positive market access shock.

In conclusion, this subsection has shed light on the importance of the border subsidy in the development of land values in the early years of reunification. The large positive market access shock may have potentially resulted in an earlier rise in land values, but the effect may have been dampened by the withdrawal of the border periphery subsidy. In addition to the adjustment time required immediately after reunification, this appears to be the reason why the positive land value growth was largely realised in the second half of the first reunification decade.

6 Conclusion

This article has offered an analysis of the effects of German reunification on the former West German border periphery exploiting the exogenous variation in market access in a difference-in-

Table 7: Border periphery subsidy

	Land value growth	
	(1)	(2)
	All	All
Reunification x border subsidy	0.123	
	(0.368)	
Border subsidy x year 1990		0.398
		(0.708)
Border subsidy x year 1992		-0.570
		(0.735)
Border subsidy x year 1994		-3.039***
		(0.653)
Border subsidy x year 1996		1.461*
		(0.813)
Border subsidy x year 1998		1.343
		(0.946)
Border subsidy x year 2000		1.376**
		(0.551)
Border subsidy	-1.321***	-1.325***
	(0.275)	(0.275)
Constant	1.065***	0.522
	(0.277)	(0.337)
Observations	16,863	16,863
R^2	0.037	0.039
Year effects	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

differences setup.

The simulation of the Helpman model provided the theoretical backbone of the analysis. We started out with the question why Redding and Sturm do not find a positive reunification effect on population growth despite a large negative division effect. Replicating their study with the inclusion of non-city boroughs (population $<$ 20,000) we find again no effect. Therefore, we put together a new data set on land values to study whether any effects are visible in prices which arguably react more quickly to changes in market access than firms and households.

Reunification did have positive effects on land value growth. These effects differed greatly between the considered subgroups. The border regions grew on average faster than the control group outside a 100km radius. The separate consideration of distance to border and the classification into rural and urban boroughs yields that rural boroughs reap a larger share of the gains. Prices adjust more quickly to the predicted levels from the Helpman model than population levels do.

Arguing that population levels are slower to adjust while land prices react more quickly to expectations, we offer an explanation for the fact that Redding and Sturm have not found a positive reunification effect. The theoretical predictions from the Helpman model are confirmed more convincingly with regard to land values. The cost of relocation of firms and households poses a hurdle to a faster response of population levels.

Revisiting the former border periphery in future decades would yield further insight into the long-run nature of the new spatial equilibrium and the persistence of land price changes.

Appendix

A Simulation and calibration – Helpman model

Parameter choices

Exogenous variables:

Elasticity of substitution:

$$\sigma = 4 \tag{12}$$

Share of spending on tradeable goods:

$$\mu = 0.66 \tag{13}$$

Fixed production cost:

$$F = 1 \tag{14}$$

Common technology parameter:

$$\phi = 1 \tag{15}$$

Constant in wage equation:

$$\xi = (F * (\sigma - 1))^{-(1/\sigma)} * ((\sigma - 1)/\sigma) * \phi \tag{16}$$

Endogenous variables:

Initial distribution of endogenous variables:

$$w_i = 1 \tag{17}$$

Interpretation of equation (C.6):
All county wages at initial iteration equal to one.

$$H_e = L * 100 \tag{18}$$

Remaining equations required to solve general equilibrium:

$$n_e = (\phi/(F * \sigma)) * L \tag{19}$$

$$p_e = (\sigma/(\sigma-1)) * (w_i/\phi) \quad (20)$$

$$PM_e = (T * (n_e * (p_e^{1-\sigma})))^{1/(1-\sigma)} \quad (21)$$

$$w_e = xi * (T * (w_i * L * (PM_e^{\sigma-1})))^{1/\sigma} \quad (22)$$

$$E_e = (w_e * L)/\mu \quad (23)$$

$$PH_e = ((1-\mu) * E_e)/H_e \quad (24)$$

$$\omega_e = w_e/((PM_e)^{\mu} * (PH_e)^{1-\mu}) \quad (25)$$

B Simulation Helpman model: long-run population equilibrium

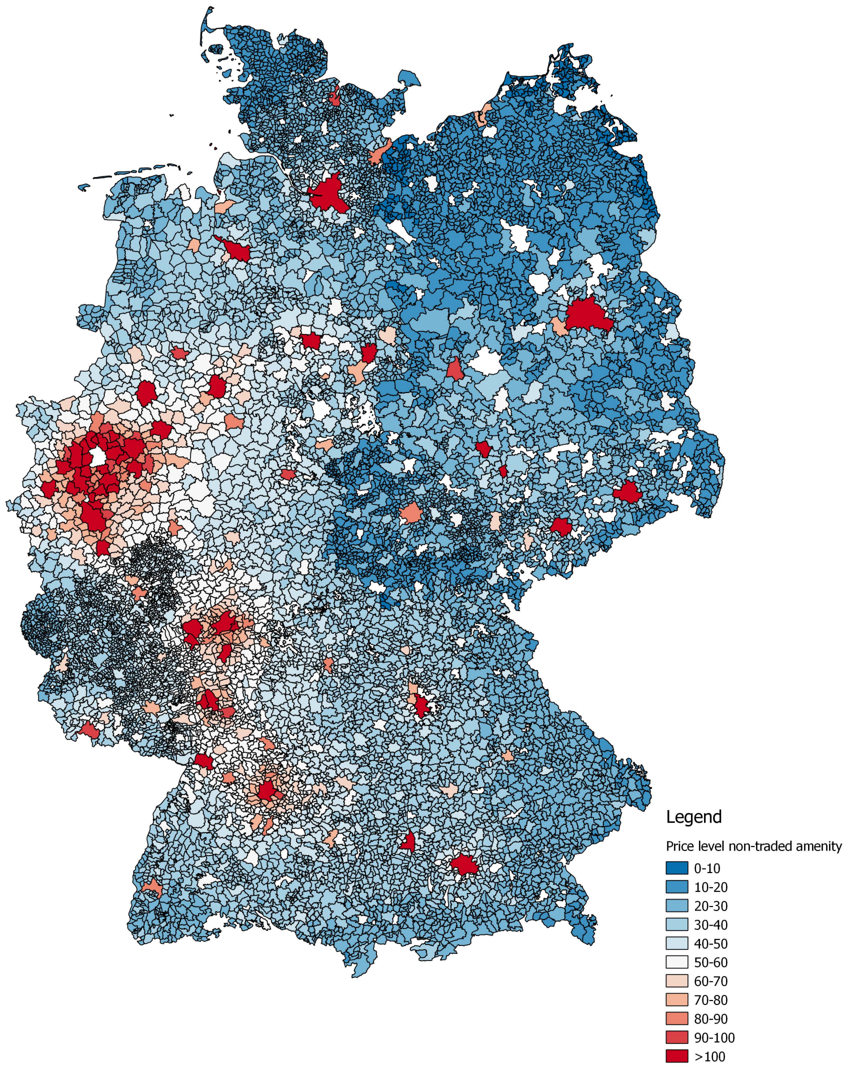
C City vs rural

Table 8 reports results of the regressions where instead of separating the sample into city and non-city samples we use interaction effects. When measured against the full sample and only including interaction effects. For readability reasons the *Reunification X Border* interations are suppressed in the table. The only significant interaction is the coefficients for rural counties in the border area.

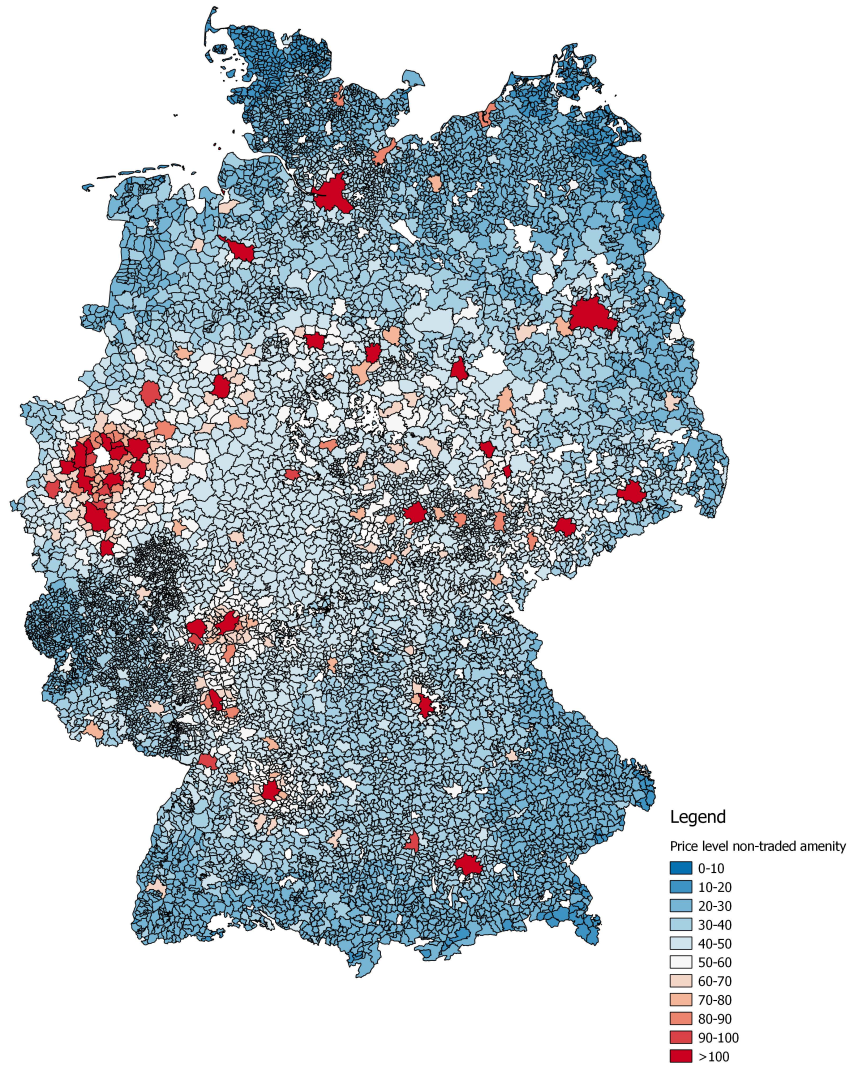
Table 8: Comparison city and non-city areas

	Land value growth			
	(1)	(2)	(3)	(4)
	All	All	All	All
Reunification x City	-0.072			
	(0.387)			
Border x Reunification x City		-0.229		
		(0.539)		
Reunification x Non-city			0.073	1.231
			(0.387)	(.378)
Border x Reunification x Non-city				1.232***
				(0.378)
City	0.334	0.320		
	(0.313)	(0.242)		
Border		-0.472***		-.628
		(0.181)		(.283)
Border x City		0.00289		
		(0.473)		
Non-city			-0.334	-.335
			(0.313)	(.242)
Border x Non-city				-.643
				(.400)
Constant	0.278	0.558**	0.540*	0.683**
	(0.254)	(0.268)	(0.293)	(0.323)
Observations	16,863	16,863	16,863	16,863
R^2	0.035	0.036	0.035	0.036
Year effects	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1



(a) Calibration pre-reunification



(b) Simulation post-reunification

Figure 10: Simulation Helpman model: long-run population equilibrium

D Spatial analysis

The market access approach incorporates interactions between different regions. If one region's market access increases, so does the market access of its neighbours. The closer this neighbour, and the lower consequently the bilateral trade costs, the more it is affected. The above analysis has restricted itself to the cross-sectional and panel structure while neglecting one potentially crucial feature of the data: the spatial dependence between regions in the dependent variable land value.

The tests confirm that the data exhibit a high degree of spatial correlation as measured by Moran's I and Geary's C. According to Anselin, Le Gallo, and Jayet (2008) the following models are appropriate depending on the structure of the spatial correlation:

- If serial correlation present, but no spatial correlation use heteroskedasticity and autocorrelation consistent (HAC) standard errors
- If spatial correlation, but no serial correlation, use clustered robust standard errors or fit spatial error model
- If both correlations present, compute spatial weights matrix W and refit model with spatial heteroskedasticity and autocorrelation consistent (SHAC) standard errors

After confirming spatial and serial correlation we compute a spatial weights matrix W_i. This weights matrix measures the haversine distance between each borough in the sample using latitude and longitude coordinates. We then invert the matrix and derive a set of weighted variables using the spatial weights. For instance $W_i \times BRW_{j,t}$ is the standard land price value in all other regions j weighted by the distance to region i. Land values that are closer to each other are therefore assigned more weight. The same method is used to weight logarithmic changes. We thereby assume that changes in neighbouring regions have an impact on land value changes on the region.

We estimate the spatial models as presented in Anselin, Le Gallo, and Jayet (2008) in different specifications:

i. *Pure space simultaneous* models, in which the dependence relates only to neighbouring locations in the same period:

$$brw_{i,t} = \gamma \; W_i \times brw_{j,t} + X_t\beta + \epsilon_t \tag{26}$$

$$\Delta \; log \; brw_{i,t} = \gamma \; W_i \times (\Delta \; log \; brw_{j,t}) + X_t\beta + \epsilon_t \tag{27}$$

ii. *Pure space recursive* models, in which the dependence pertains only to neighbouring locations in a previous period:

$$brw_{i,t} = \gamma \; W_i \times brw_{j,t-1} + X_t\beta + \epsilon_t \tag{28}$$

$$\Delta \; log \; brw_{i,t} = \gamma \; W_i \times (\Delta \; log \; brw_{j,t-1}) + X_t\beta + \epsilon_t \tag{29}$$

iii. *Time-space recursive* models, in which the dependence relates to both the location itself as well as its neighbours in the previous period:

$$brw_{i,t} = \phi brw_{i,t-1} + \gamma \; W_i \times brw_{j,t-1} + X_t\beta + \epsilon_t \tag{30}$$

$$\Delta \; log \; brw_{i,t} = \phi \; \Delta \; log \; brw_{i,t-1} + \gamma \; W_i \times (\Delta \; log \; brw_{j,t-1}) + X_t\beta + \epsilon_t \tag{31}$$

iv. *Time-space simultaneous* models, which include a time lag for the location itself together with a contemporaneous spatial lag:

$$brw_{i,t} = \phi brw_{i,t-1} + \gamma \; W_i \times brw_{j,t} + X_t\beta + \epsilon_t \tag{32}$$

$$\Delta \; log \; brw_{i,t} = \phi \; \Delta \; log \; brw_{i,t-1} + \gamma \; W_i \times (\Delta \; log \; brw_{j,t}) + X_t\beta + \epsilon_t \tag{33}$$

Table D summarises the results. The results from the spatial analysis confirm a significant level of spatial interdependence. All specifications yield statistically significant coefficients. Regardless of the spatial and the time dimension the coefficients remain significant. We find that the level of land prices in neighbouring regions impacts your own levels. We find that regions within the border variable have lower land values and lower land value changes than the control regions. In addition, we find that the contemporaneous change of land values in neighbouring regions have a positive impact on a regions's land value change. The same applies to lag changes of neighbouring regions (i.e. neighbouring regions change in $t - 1$). Somewhat surprisingly the coefficient for the lag change in a region's land value $\Delta \; log \; brw_{i,t-1}$ has a negative effect. This might be interpreted as a reversion to the mean.

Table 9: Spatial analysis

	BRW (1)	Δ BRW (2)	BRW (3)	Δ BRW (4)	BRW (5)	Δ BRW (6)	BRW (7)	Δ BRW (8)
BRW weighted	0.0878***						0.0201***	
	(0.00120)						(0.000919)	
Market Potential	-0.196***		0.183***		0.0969***		0.0592***	
	(0.0156)		(0.0281)		(0.00869)		(0.00878)	
Border	-43.50***	-0.0231***	-54.14***	-0.0173***	-10.86***	-0.0229***	-10.26***	-0.0324***
	(3.296)	(0.00382)	(3.847)	(0.00477)	(1.125)	(0.00464)	(1.087)	(0.00438)
Δ BRW weighted		0.0726***						0.0808***
		(0.00231)						(0.00330)
Δ MP		-0.000953***		0.00200***		0.00266***		-0.00178***
		(0.000338)		(0.000512)		(0.000497)		(0.000343)
$(\text{BRW weighted})_{t-1}$			0.145***		0.0251***			
			(0.00240)		(0.00162)			
$(\Delta\text{ BRW weighted})_{t-1}$				0.0156***		0.0350***		
				(0.00330)		(0.00341)		
BRW_{t-1}					1.367***		1.347***	
					(0.00916)		(0.00854)	
$\Delta\text{ BRW}_{t-1}$						-0.228***		-0.203***
						(0.0141)		(0.0125)
Constant	51.58***	-0.00227	-115.2***	0.0950***	-55.16***	0.0856***	-44.81***	0.00592
	(5.368)	(0.00419)	(10.67)	(0.00780)	(3.066)	(0.00758)	(3.028)	(0.00709)
Observations	5,886	5,886	3,924	3,924	3,924	3,924	3,924	3,924
Number of AGS	1,962	1,962	1,962	1,962	1,962	1,962	1,962	1,962

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

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