The Costs of Remoteness: Evidence from German Division and Reunification*

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Abstract

This paper exploits the division of Germany after the Second World War and the reunification of East and West Germany in 1990 as a natural experiment to provide evidence for the importance of market access for economic development. In line with a standard new economic geography model, we find that following division cities in West Germany that were close to the new border between East and West Germany experienced a substantial decline in population growth relative to other West German cities. We provide several pieces of evidence that the decline of the cities along the new border can be entirely accounted for by their loss of market access and is not due to other factors such as differences in industrial structure or differences in the degree of war-related disruption. Finally, we find some first evidence of a recovery of the border cities after the re-unification of East and West Germany.

Keywords: Market Access, Economic Geography, German Division, German Reunification

JEL classification: F15, N94, O18

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1. Introduction

One of the most striking empirical regularities is the huge divergence in economic activity both within and across countries. A number of – not mutually exclusive – fundamental determinants of this divergence have been proposed.[1] An influential view is that differences in institutions, such as the protection of private property, can explain a large part of the differences in economic performance.[2] An alternative explanation is that differences in natural endowments, such as climatic conditions and the disease environment, can account for these income differences.[3] Another view that has featured less prominently in the debate is the role of market access in explaining spatial variation in economic activity, as emphasized in the literature on new economic geography following Krugman (1991), Hanson (1996a) and Davis and Weinstein (2002).[4]

In this paper we exploit the division of Germany after the Second World War and the reunification of East and West Germany in 1990 as a source of exogenous variation to provide evidence for the causal importance of market access for economic development. Map 1 illustrates how the new border between East and West Germany that emerged in the wake of the Second World War separated areas that had been part of the same state since 1871 and had been highly integrated for several centuries. The drawing of the border was motivated by military considerations and was based on allocating occupation zones of roughly equal population to the American, British and Russian armies. With the collapse of the wartime alliance between the Western Powers and Russia, the new border between East and West Germany was completely sealed and all local economic interactions across the border ceased.

The key idea behind our empirical approach is that West German cities close to the new border experienced a disproportionate loss of market access relative to other West German cities. The reason is that West German cities close to the new border lost nearby trading partners with whom they could interact at low transport costs prior to division. In contrast, the effect on West German cities further from the border was more muted, because they were more remote from the trading partners lost, and therefore already faced higher transport costs prior to division. We exploit this differential loss of market access by comparing the development of West German cities close to and

[1] Our discussion is not exhaustive and a comprehensive review is provided by for example Acemoglu (2007).

[2] See for example Acemoglu *et al.* (2001), La Porta *et al.* (1998) and Rodrik *et al.* (2004).

[3] See for example Bloom and Sachs (1998), Diamond (1997) and Gallup *et al.* (1998).

[4] Fujita *et al.* (1999) and Baldwin *et al.* (2003) provide syntheses of the theoretical research, and Overman *et al.* (2003) and Head and Mayer (2004a) survey the empirical work. The idea that market access is important dates back to at least Marshall (1920), who also discusses knowledge spillovers and supplies of specialized skills as other potential reasons for agglomeration, to which we return below.

far from the East-West border both before and after the division of Germany.

Our approach has a number of attractive features. First, in contrast to cross-country studies there is no obvious variation in institutional quality that could explain the differential performance of the cities in our sample, as both our treatment and control cities are part of the same country throughout our sample period. Second, as we follow cities within West Germany over time, there are no straightforward explanations for our findings in terms of changes in natural endowments, such as changes in climatic conditions or the disease environment. Third, the change in market access following German division is much larger than typically observed in other contexts and we are able to observe the effects over a long period of time. Fourth, as the drawing of the border dividing Germany into East and West Germany was based on military considerations it is unlikely to be correlated with pre-war characteristics of cities. Taken together these features of our approach enable us to empirically disentangle the effects of market access from other determinants of comparative economic development.[5]

Our analysis proceeds as follows. To guide our empirical investigation we develop a multi-region version of the Helpman (1998) model of economic geography. The model formalizes the role of market access in shaping the distribution of population across space. We calibrate the model to city-level data for Germany in 1939 and simulate the impact of the post-war division on the equilibrium distribution of population across West German cities.[6] We focus on West Germany since it remained a market-based economy after division, in which one would expect the market access mechanism emphasized in the model to apply. The model has two central predictions for the impact of division. First, the relatively larger loss of market access for cities close to the new border leads to a reallocation of population away from those cities to other West German cities. Second, the greater dependence of small cities on markets in other cities implies that this effect will be particularly pronounced for small cities.

We find strong empirical support for these predictions using a rich panel of data on West German cities over the period 1919 to 2002. Our basic empirical strategy is a 'difference in differences' specification that compares population growth in West German cities close to and far from the new East-West German border both prior to and after division. We find that over the 40 year period of division, the population of West German cities close to the East-West border declined at a annualized rate of about 0.75 percentage points relative to other West German cities, implying a

[5] While the nature of our experiment allows us to abstract from differences in natural endowments and institutions to reveal the role played by market access, this clearly does not imply that these other considerations are not also important for economic development.

[6] Throughout the paper, the phrases "pre-war" and "post-war" relate to the Second World War.

cumulative reduction in the relative size of the East-West border cities of around one third. This difference in population growth rates for the two groups of cities is not apparent prior to division but emerges in its immediate aftermath. The estimated effect is strongest in the 1950s and 1960s and declines over time, consistent with gradual adjustment towards a new long-run equilibrium distribution of population. Furthermore, the relative decline is more than twice as large for cities with a below median population as for those with an above median population, in line with the second prediction of the model.

While suggestive of the importance of market access, the observed decline in the cities along the East-West German border could at least in part be due to alternative explanations. First, cities close to the new border could have specialized in industries that experienced a secular decline in the post-war period (e.g. coal and other mining industries). Second, the cities along the new border may have suffered differential levels of war-related disruption, both in terms of war destruction and refugees from the former Eastern parts of Germany, which could have influenced their relative population growth. Third, increasing economic integration between West Germany and its Western European trade partners could have elevated population growth in cities in the West of West Germany, thereby contributing towards the relative decline of cities along the East-West German border. Finally, a belief that the East-West German border cities could be particularly vulnerable in case of a new armed conflict in Western Europe may have contributed towards their relative decline.

To further strengthen the case that our results are explained by the loss of market access due to German division, and to exclude these alternative explanations, we provide several additional pieces of evidence. First, we use our theoretical model to show that for plausible parameter values a market access based explanation can quantitatively explain both the overall relative decline of the cities along the East-West German border and the finding that the decline is more pronounced for small cities. Second, we establish that neither patterns of specialization nor the degree of war-related disruption can account for the relative decline of the cities along the new border. Third, while we find some evidence that Western economic integration elevated population growth in cities in the far West of West Germany, controlling for Western economic integration does not substantially change our estimate of the relative decline of cities along the East-West German border. Finally, we present several pieces of evidence that cast doubt on the hypothesis that the decline of the East-West German border cities was driven by fear of a further armed conflict.

Although the division of Germany appeared to be a permanent feature of the geopolitical landscape, the collapse of communism led to the reunification of East and West Germany in 1990, which caught most contemporary observers by surprise. While reunification therefore provides an additional source of exogenous variation, it plausibly involves a much smaller change in market access. In line with this, we find a similar pattern of results but on a much smaller scale

A substantial empirical literature has examined the link between access to markets and economic development.[7] While there is a well established association between levels of economic activity and market access, the central challenge facing this literature is to establish that this association is indeed causal. One strand of literature has used instrumental variables for market access such as lagged population levels or the distance of U.S. counties from the Eastern seaboard. However, these instruments are only valid under demanding identification assumptions, which are unlikely to be satisfied in practice. For example, institutions, natural endowments and market access are all strongly persistent, and so it is unlikely that lagged population affects economic activity solely through market access. Similarly, distance from the Eastern seaboard of the U.S. could capture a wide range of factors including natural advantage and is unlikely to only affect economic activity through market access.

A second strand of literature follows Hanson's (1996a, 1996b, 2001) analysis of the effects of the trade integration between Mexico and the United States, and considers trade liberalizations as a source of variation in market access.[8] The use of trade liberalizations as a source of exogenous variation in market access is, however, also potentially problematic. The changes in market access are typically small, are usually implemented over an extended period of time, and are often accompanied by other policy changes. Furthermore, a large political economy literature models trade policy as determined by industry characteristics, such as supply and demand elasticities and the ratio of imports to industry output.[9] Therefore, changes in trade policy may not only alter market access and so result in changes in income or production, but changes in income or production may also lead to endogenous changes in trade policy and hence market access.

The remainder of the paper is organized as follows. Section 2 discusses the historical background to German division and reunification. Section 3 develops the theoretical framework and derives the two key empirical predictions. Section 4 discusses our empirical strategy and data. Section 5

[7]Recent contributions include Davis and Weinstein (2002, 2003), Hanson (2005), Hanson and Xiang (2004), Head and Mayer (2004b, 2006), and Redding and Venables (2004). Related work examines the link between income and openness to international trade, as in Frankel and Romer (1999) and Alcalá and Ciccone (2002).

[8]Recent contributions include Overman and Winters (2004) for the United Kingdom, Tirado et al. (2002) for early-twentieth century Spain, and Wolf (2007) for early-twentieth century Poland.

[9]See for example the large literature following Grossman and Helpman (1994). The theoretical predictions of this literature receive empirical support in Goldberg and Maggi (1999) and subsequent contributions.

presents our main empirical results. Section 6 discusses the additional pieces of evidence supporting a market access based explanation. Section 7 examines reunification and Section 8 concludes.

2. Historical Background

In the wake of the Second World War Germany's boundaries changed dramatically. Map 1 illustrates how pre-war Germany was divided into four different parts: West and East Germany, areas that became part of Poland and finally an area that became part of Russia. West Germany, which was the largest of these parts, accounted for approximately 53 percent of the area and just over 58 percent of Germany's 1939 population of 69.3 million.[10] East Germany comprised approximately 23 percent of the area and 22 percent of the 1939 population of Germany. The areas that became part of Poland and Russia contained 24 percent of the area of pre-war Germany and accounted for nearly 14 percent of the 1939 population. East and West Berlin comprised the remaining 6 percent of the 1939 population. The new border between East and West Germany cut through some of the most central regions of pre-war Germany that had been integrated for several centuries.[11]

The political process leading to the eventual division of pre-war Germany took several unexpected turns (see for example Franklin 1963, Kettenacker 1989 and Loth 1988). While a number of proposals to divide Germany after its eventual defeat were discussed during the early phase of the Second World War, the United States and Russia backed off such plans towards the end of the war. Instead the main planning effort was to organize the eventual military occupation of Germany. Early on it was decided to allocate separate zones of occupation to the American, British and Russian armies. The planning process for the zones began in spring 1943, negotiations continued during 1944, and the protocol formalizing the zones was signed in London in September 1944. The protocol divided pre-war Germany into three zones of roughly equal population, after excluding the areas that were expected to become part of Poland and Russia. Additionally it was agreed that Berlin would be jointly occupied. The protocol was modified in 1945 to create a small French zone by reducing the size of the British and American zones.

As tensions between the Western allies and Russia increased with the onset of the Cold War, the

[10] All figures in this paragraph are taken from the 1952 edition of the "Statistisches Jahrbuch für die Bundesrepublik Deutschland." The data on area and 1939 population are based on the 1937 boundaries of Germany prior to territorial expansion immediately prior to and during the Second World War.

[11] As a point of comparison the territory of Germany was reduced by just 13 percent, which contained approximately 10 percent of its population, as part of the peace treaty at the end of World War I ("Statistisches Jahrbuch für das Deutsche Reich" 1921/1922). Furthermore, these areas were small border regions along the eastern, western and northern edges of Germany.

zones of occupation became the nucleus for the foundation of an East German and a West German state in 1949. The territory of West Germany was the combined area of the British, French and American zones, and was extended to include the Saarland from 1957 onwards. East Germany was founded on the Russian zone of occupation. While the two countries maintained some politically motivated and largely symbolic economic cooperation, local economic links between areas on either side the border were suppressed from 1949 when East Germany introduced central planning into its economy. From 1952 onwards a sophisticated system of border fences and other barriers was constructed on the Eastern side of the border to prevent civilians escaping from East Germany. As a result the new border between East and West Germany was completely sealed.

In the closing stages of the Second World War and its immediate aftermath, there was a wave of migration from the former Eastern parts of Germany and other German settlements in Eastern Europe to the future West Germany. Even though the main border between East and West Germany was closed in 1952, there remained until 1961 the possibility for limited transit between East and West Berlin. After the construction of the Berlin Wall in August 1961, migration between East and West Germany virtually ceased.[12]

The division of Germany was formalized in international treaties and was generally believed to be permanent.[13] Increasing dissatisfaction among East Germans about heavy restrictions on mobility, lack of personal freedom and the declining performance of the East German economy led to large scale demonstrations in 1989 and culminated in the fall of the Berlin Wall on 9 November 1989. Only eleven months later East and West Germany were formally reunified on 3 October 1990.

3. Theoretical Framework

In this section, we outline a multi-region version of the Helpman (1998) model of economic geography, calibrate the model to data for pre-war Germany, and use the calibrated model to simulate the effects of German division.[14] The model determines the distribution of population across cities as the outcome of a tension between agglomeration and dispersion forces. The two

[12] Between the census in 1939 and 1950 the population of what would later become West Germany increased from 39.3 million to 47.7 million. Between 1950 and 1961, an estimated 3.6 million refugees migrated from East to West Germany. In the three years up to 1961, the average flow of refugees was around 210,000 per year. In the three years after 1961, the average flow dropped to around 36,000 per year. These flows accounted for around one third and 5 percent of the population growth rate for West Germany over the respective periods (see Bethlehem 1982).

[13] After the signing of the Basic Treaty ("Grundlagenvertrag") in December 1972, which recognized "two German states in one German Nation", East and West Germany were accepted as full members of the United Nations. West German opinion polls in the 1980s show that less than 10 percent of the respondents expected a re-unification to occur during their lifetime (Herdegen 1992).

[14] A more detailed exposition of the model is contained in a web-based technical appendix. For related theories of city development, see Henderson (1974) and Black and Henderson (1999).

agglomeration forces are a “home market effect,” where increasing returns to scale and transport costs imply that firms want to concentrate production near to large markets, and a “cost of living effect,” where consumer love of variety and transport costs imply a lower cost of living near to large markets. The two dispersion forces are a “market crowding effect,” where transport costs imply that firms close to large markets face a larger number of lower-priced competitors, and a “congestion effect,” where an increase in population raises the price of a non-traded amenity, and so implies a higher cost of living near to large markets.

3.1. Endowments, Preferences and Technology

The economy consists of a fixed number of cities $c \in \{1, \ldots, C\}$, each of which is endowed with an exogenous stock of a non-traded amenity, H_c, in perfectly inelastic supply.[15] There is a mass of representative consumers, L, who are mobile across cities and are endowed with a single unit of labor which is supplied inelastically with zero disutility. Each consumer allocates a constant share of expenditure μ to horizontally differentiated varieties of traded manufacturing goods, and devotes the remaining share $(1-\mu)$ to consumption of the non-traded amenity, where $0 < \mu < 1$. The differentiation of manufacturing varieties takes the Dixit-Stiglitz form, so that there is a constant elasticity of substitution $\sigma > 1$ between varieties.

The production of each manufacturing variety involves a fixed cost and a constant marginal cost in terms of labor, which is the sole factor of production. Manufacturing varieties are produced under conditions of monopolistic competition, and can be traded between cities subject to an iceberg transport cost, whereby $T_{ic} > 1$ units must be shipped from city i to city c in order for one unit to arrive.

3.2. Equilibrium City Size

The population of cities is determined endogenously by a labor mobility condition which requires workers to receive the same real wage in all cities that are populated in equilibrium. The real wage in a city depends on the consumer price index for traded manufacturing varieties and the price of the non-traded amenity. Therefore, labor mobility implies:

$$\omega_c \equiv \frac{w_c}{\left(P_c^M\right)^{\mu}\left(P_c^H\right)^{1-\mu}} = \omega \qquad \text{for all } c \tag{1}$$

[15] In Helpman (1998), the stock of the non-traded amenity is interpreted as housing, but it captures any immobile resource which generates congestion costs, and therefore acts as a force for the dispersion of economic activity.

where ω_c is the real wage; w_c is the nominal wage; P_c^M is the Dixit-Stiglitz price index for manufacturing varieties; and P_c^H is the price of the non-traded amenity. Substituting for w_c, P_c^M and P_c^H, the labor mobility condition can be re-written to yield an expression linking the equilibrium population of a city (L_c) to two endogenous measures of market access, one for firms (FMA_c) and one for consumers (CMA_c), and the exogenous stock of the non-traded amenity (H_c):

$$L_c = \chi(FMA_c)^{\frac{\mu}{\sigma(1-\mu)}} (CMA_c)^{\frac{\mu}{(1-\mu)(\sigma-1)}} H_c \tag{2}$$

where χ is a function of parameters and the common real wage ω.

Firm market access (FMA_c) summarizes the proximity of firms in a city to demand in all markets and determines the highest nominal wage that firms can afford to pay in a zero-profit equilibrium. It is defined as: $FMA_c \equiv \sum_i (w_i L_i) \left(P_i^M\right)^{\sigma-1} (T_{ci})^{1-\sigma}$, where demand in market i for varieties produced by firms in city c depends on total labor income ($w_i L_i$), the manufacturing price index (P_i^M), and transport costs (T_{ci}). Firm market access includes both the "home market effect" (through income and hence expenditure) and the "market crowding effect" (through the manufacturing price index). Consumer market access (CMA_c) summarizes consumers' access to manufacturing goods, including the number of varieties produced in each location (n_c), the 'free on board' prices of those varieties (p_i) and the costs of transportation (T_{ic}): $CMA_c \equiv \sum_i n_i (p_i T_{ic})^{1-\sigma}$. Consumer market access captures the "cost of living effect," since cities with higher consumer market access have lower manufacturing price indices. Finally, the stock of the non-traded amenity is the source of the "congestion effect."

The division of Germany reduces the market access of both firms and consumers in cities close to the East-West German border relative to that in other West German cities. In our empirical work we are concerned with the impact of division on city population, which clearly depends on its impact on the market access of both firms and consumers. Therefore we use the generic term market access below to refer to both of these dimensions of proximity to markets.

The labor mobility condition (1) determining the relative populations of cities is clearly a long-run relationship. After an exogenous shock adjustment costs imply that it will take time for city populations to adjust towards their new steady-state values. The simplest way to model such an adjustment process is to assume, as in Krugman (1991) and Fujita *et al.* (1999), that migration is proportional to the real wage gap between cities.[16]

As usual in the economic geography literature, the non-linearity of the model implies that

[16] Baldwin (2001) replaces this myopic migration decision with forward-looking rational expectations and finds that the qualitative implications of the economic geography model remain unchanged.

there are no closed form solutions for the endogenous variables. We therefore calibrate the model to observed city populations in pre-war Germany and simulate the general equilibrium impact of division.

3.3. Calibration and Simulation

The dataset used for the calibration and simulation is described in detail in the next section and is the same as that used in the econometric estimation. We assume central values for the main parameters of the model from the existing literature. The elasticity of substitution between manufacturing varieties (σ) is assumed to equal four, which is in line with the estimates in Feenstra (1994). The share of manufacturing in expenditure (μ) is assumed to equal two thirds, implying a share of the non-traded amenity in expenditure of one third, which is consistent with consumer expenditure survey estimates of the share of consumer expenditure accounted for by housing. Following the large gravity equation literature in international trade, we model bilateral transport costs as a function of distance. The elasticity of transport costs with respect to distance (ϕ) is assumed to be equal to one third, which is in line with the range of estimates using international trade data in Hummels (2001) and Limao and Venables (2001).

These parameters influence the properties of the model in two ways. The first channel is through the strength of agglomeration and dispersion forces, which is captured by $\sigma(1-\mu)$ in the model. As the elasticity of substitution σ increases, the varieties of different cities become closer substitutes, diminishing the benefits of proximity to large markets. As the share of the non-traded amenity in expenditure $(1-\mu)$ increases, the non-traded amenity becomes more important as a source of congestion. For the central parameter values from the existing literature, $\sigma(1-\mu) > 1$, and so the Helpman (1998) model has a unique stable equilibrium.[17]

The second channel is through the coefficient on distance in the expressions for market and supplier access, which is equal to $(1-\sigma)\phi$, because the elasticity of transport costs with respect to distance is equal to ϕ and the elasticity of market and supplier access with respect to transport costs is equal to $(1-\sigma)$. As the distance coefficient converges to zero all cities gain equal access to one another's markets and location becomes irrelevant, while as the distance coefficient converges to minus infinity trade between cities approaches zero and markets in other cities become irrelevant. The benefits of proximity to markets in other cities are therefore greatest for intermediate values

[17] If instead parameter values were such that $\sigma(1-\mu) < 1$, the Helpman (1998) model has multiple equilibria. In either case market access is central in determining the equilibrium distribution of population across cities, but when there are multiple equilibria, German division could shift the economy between alternative equilibrium population distributions. We return to the issue of multiple equilibria in Section 6 below.

of the distance coefficient. For the parameter values above, $(1-\sigma)\,\phi = -1$, which lies in the centre of the range of values for the distance coefficient estimated using international trade data (see for example Anderson and van Wincoop 2003 and Redding and Venables 2004).

We determine the stock of the non-traded amenity in each city by calibrating the model to the 1939 distribution of population across cities in pre-war Germany. As discussed further in the web-based technical appendix, we use the system of equations that determine general equilibrium to solve for the value that the non-traded amenity stock in each city must take in order for the 1939 population distribution to be an equilibrium of the model with real wage equalization. After calibrating the model, we next simulate the impact of Germany's division by assuming that transport costs between West German cities and cities East of the new border between East and West Germany become prohibitive. The simulation solves for the new general equilibrium of the model, allowing the population of the West German cities to endogenously reallocate until a new long-run equilibrium is reached where real wages are equalized across West German cities.[18]

Two striking regularities emerge from the simulation that are central to our empirical work. First, Figure 1 graphs average percentage changes in city population in the simulation against distance from the East-West German border. For ease of interpretation, the percentage changes have been normalized so that their mean across West Germany is equal to zero.[19] The figure shows a sharp decline in the population of cities close to the East-West German border, which diminishes rapidly with distance from the border. Second, Figure 2 displays the difference between the average percentage change in population for cities within 75 kilometers of the East-West German border and that for cities beyond 75 kilometers from the border. This difference is shown separately for cities with a population at the beginning of our sample period less than and greater than the median for the future West Germany. The figure shows that the relative decline of cities along the East-West German border is larger for small cities than for large cities.[20]

The intuition for the decline of cities close to the new border is as follows. The drawing of the border between East and West Germany has three immediate effects. First, consumers in all West German cities lose access to manufacturing goods from the former Eastern parts of Germany, which

[18] The qualitative results of the simulation do not depend on holding the total West German population constant at its 1939 level.

[19] By construction, the mean of the absolute changes in city populations equals zero, since the total population across all West German cities is held constant in the simulation. However, since cities are of different size, the mean percentage change in city population need not equal zero.

[20] The size of the mean decline in city populations in Figure 1 does not necessarily fall monotonically with distance from the East-West border for two main reasons. First, distance to the border is only an imperfect proxy for the amount of economic hinterland that a city has lost due to the border. Second, as Figure 2 shows, the impact of division depends on city size, which varies across distance cells.

raises consumers' cost of living and hence reduces real wages (the "cost of living effect"). Second, there is a reduction in market access for all West German firms due to the reduced expenditure on West German manufacturing varieties, which reduces the nominal wage, and so also reduces real wages (the "home market effect"). Third, there is a reduction in the number of competing varieties available in West German cities due to the loss of competitors from the former Eastern parts of Germany (the "market crowding effect"), which allows West German firms to pay higher nominal wages, thereby increasing real wages. Because there are gains from trade in the model, the "cost of living effect" and "home market effect" are stronger than the "market crowding effect." Therefore, the immediate impact of the loss of potential trading partners in the former Eastern parts of Germany is to reduce the real wage in all West German cities.

The immediate reduction in the real wage is, however, larger in cities close to the East-West border than in those further from the border. The reason is that cities close to the new border had lower transport costs to cities in the former Eastern parts of Germany prior to division, and so experience a greater reduction in the gains from trade. This differential change in real wages triggers a population outflow from the cities close to the new border, which further reduces their market and supplier access relative to other cities. The mechanism that restores real wage equalization within West Germany is that the population movements between cities trigger a fall in the price of the non-traded amenity in the cities close to the new border relative to other West German cities.[21]

The finding that division has a greater impact on city population for small cities than for large cities is also very intuitive. In small cities, the *own* market is less important relative to markets in other cities. As a result, the loss of access to markets in the former Eastern parts of Germany has a larger proportionate impact on overall market access for small cities than for large cities.

4. Empirical Strategy and Data

4.1. Data Description

Our basic dataset is a panel of West German cities covering the period from 1919 until 2002, which includes the populations of all West German cities which had more than 20,000 inhabitants in 1919. This choice of sample ensures that the composition of cities is not itself affected by the division of Germany after the Second World War. For the pre-war period city populations are only available for the census years, which were 1919, 1925, 1933 and 1939. For the division period we have assembled data at 10 year intervals from 1950 (which is the first post-war year for which

[21] If the supply of the non-traded amenity was allowed to adjust, depreciating in cities with falling population and expanding in cities with rising population, this would magnify the relative decline of the East-West border cities.

reliable population data are available) to 1980, and also for 1988 immediately prior to reunification. For the reunification period, we have collected data for 1992 immediately after reunification and 2002. A detailed description of the sources of all our data is contained in the data appendix.

Our data refer to administrative cities as data on metropolitan areas is unavailable over such a long time period for Germany. To ensure that the data on administrative cities are as comparable as possible over time, we aggregate cities in our sample which merge between 1919 and 2002 for all years in our sample. In addition we are able to track all settlements with a population greater than 10,000 in 1919 which merge with a city in our sample, in which case we aggregate the settlement with the city for all years in the sample.[22] This results in smooth population series for most cities. Finally, to examine the robustness of our results to smaller changes in city boundaries, we record all city-year observations in which a city reports a change in its boundaries not captured in our aggregations.

After aggregating cities that merge we are left with a sample of 119 West German cities, not including West Berlin, which we exclude from all our estimates to avoid that any of our results are driven by the isolated location of West Berlin as an island within East Germany.[23] Table 1 lists the subset of 20 cities out of these 119 cities that were located within 75 kilometers of the East-West border. Distance to the border is measured as the shortest Great Circle Distance from a city to any point on the border between East and West Germany.

In addition to our basic population dataset, we have obtained information on a variety of other city characteristics. First, for 1939 we have assembled a detailed breakdown of employment in each city into 28 sectors. Second, we have gathered data on three measures of the degree of war-related disruption by city: the amount of rubble in cubic metres per capita; the number of destroyed dwellings as a percentage of the 1939 stock of dwellings; and the percentage of a city's population that were recorded as refugees from the former Eastern parts of Germany in the 1961 West German population census, which was conducted only weeks before the building of the Berlin Wall essentially eliminated East-West migration. Finally, we have also collected data on the populations of all other cities that were part of Germany prior to the Second World War and

[22] Overall twenty cities in our sample are the result of aggregations. Of these twenty cities, eight are involved in aggregations with settlements with a population between 10,000 and 20,000 in 1919. The web-based technical appendix reports details of these aggregations.

[23] We have also excluded the cities Saarbrücken, Saarlouis and Völklingen, which are located in the Saarland on the Western fringes of West Germany. The Saarland was under French administration after World War I until 1935 and also after World War II until 1957, which substantially reduces the amount of data available for these cities and also makes it questionable whether they are a valid control group. Including the available information for these cities in the sample does not change any of our results.

had more than 20,000 inhabitants in 1919, which are used in the calibration of the model. For this purpose we have also collected data on the latitude and longitude of each city in our sample and computed the great circle distance between cities. The distribution of all cities in our dataset within pre-war Germany is shown in Map 1.

4.2. Empirical Strategy

The first main prediction of our theoretical model is that the imposition of the East-West border will result in a relocation of population from West German cities close to the new border to other West German cities. In the transition to the new long-run equilibrium, cities close to the new border will experience a reduction in population growth relative to other West German cities. Similarly, the removal of this border due to the reunification of East and West Germany in 1990 should increase the relative population growth of cities close to the East-West border.

To investigate this hypothesis, we adopt a simple 'difference in differences' methodology. We compare the growth performance of West German cities which were located close to the border between East and West Germany (our treatment group) with the growth performance of other West German cities (our control group). We examine the effects of division by undertaking this comparison before and after the division of Germany. When we come to examine reunification in Section 7 below, we undertake a similar comparison for the periods of division and reunification. Our baseline empirical specification is as follows:

$$Popgrowth_{ct} = \beta Border_c + \gamma \left(Border_c \times Division_t \right) + d_t + \varepsilon_{ct} \tag{3}$$

where $Popgrowth_{ct}$ is the annualized rate of population growth over the periods 1919-25, 1925-33, 1933-39, 1950-60, 1960-70, 1970-80 and 1980-88 in West German city c at time t;[24] $Border_c$ is a dummy which is equal to one when a city is a member of the treatment group of cities close to the East-West border; $Division_t$ is a dummy which is equal to one when Germany is divided; d_t are a full set of time dummies and ε_{ct} is the error term. For our basic results we classify cities as close to the East-West border if they were within 75 kilometers of this border. We return to this choice of cut-off below and show that it is empirically plausible and corroborated by an alternative non-parametric estimation approach. To allow for serial correlation of ε_{ct} within cities over time without imposing a particular structure on the form of the serial correlation, we adjust the standard

[24] We exclude the 1939-1950 difference to abstract from the Second World War period. However, all our results are robust to including this difference in our estimation.

errors for clustering at the city level.[25] Finally, to assess the robustness of our basic findings we also consider a number of augmented versions of the baseline specification.

The specification (3) allows for unobserved fixed effects in city population levels, which are differenced out when we compute population growth rates. The time dummies control for common macroeconomic shocks which affect the population growth of all West German cities and secular trends in rates of population growth over time. They will also capture any effect of division on the average population growth rate of all West German cities. The coefficient β on the border dummy captures any systematic difference in rates of population growth between treatment and control groups prior to division. Our key coefficient of interest is γ and the first main prediction of the theoretical model is that this coefficient should be negative.

The second main prediction of the theoretical model is that the imposition of the East-West border should have a larger effect on small than on large cities. A simple way of examining this additional prediction of the model is to re-estimate our baseline specification (3) separately for cities with a 1919 population below and above the median value for the future West Germany. We split the sample into small and large cities based on 1919 populations so as to ensure that the split is not driven by population growth during the sample period.

5. Baseline Empirical Results

5.1. Basic Difference in Differences Analysis

Before we estimate our baseline specification (3), Figures 3 and 4 summarize the impact of division. Figure 3 graphs the evolution of total city population in the treatment group of cities along the East-West German border and the control group of other West German cities. For each group, total population is expressed as an index relative to its 1919 value. The two vertical lines indicate the year 1949 when the Federal Republic of Germany (West Germany) and the German Democratic Republic (East Germany) were established and the year 1990 when East and West Germany were reunified. Figure 4 graphs the difference between the two population indices and corresponds to a simple graphical difference in differences estimate of the impact of division.

In the period prior to the Second World War, the population growth of the two groups of cities is very similar, with the treatment cities experiencing a slight relative decline during the Great Depression of the early 1930s, but recovering to the trend rate of growth of the control cities by

[25] Bertrand *et al.* (2004) examine several approaches to control for serial correlation within each cross-section unit over time in panel data. They show that clustering the standard errors on each cross-section unit performs very well in settings with at least 50 cross-section units, which is the case in our application.

1939. During the Second World War and its immediate aftermath, the treatment cities experience marginally higher population growth than the control cities, probably due to migration from the Eastern parts of pre-war Germany.

This pattern changes sharply after 1949, when East and West Germany emerge as separate states with different economic systems and local economic links are severed. From this point onwards, treatment cities experience substantially lower rates of population growth than control cities. Population in the treatment cities along the East-West German border actually falls between 1960 and 1980, whereas population in the control cities continues to grow. By the early 1980s, the discrepancy in rates of population growth begins to close, consistent with the idea that the negative treatment effect of division has gradually worked itself out and the distribution of population in West Germany is approaching a new steady state.

Following reunification in 1990, there is a step-increase in city population in West Germany, reflecting migration from the former East Germany. This migration raised population in the control cities by somewhat more than in the treatment cities. From 1992 onwards, population in the treatment cities grows somewhat faster than in the control cities, which is consistent with the beginning of a recovery in the cities along the East-West German border due to improved market access after reunification.

5.2. Parametric Estimates

Table 2 contains our basic parametric results. In Column (1) we estimate our baseline specification in equation (3). The coefficient β on the border dummy is positive but not statistically significant, which implies that there is no evidence of differences in population growth between treatment and control cities prior to division. This confirms the pattern visible in Figures 1 and 2 and is consistent with the drawing of the East-West German border being driven by military considerations during the Second World War that were uncorrelated with pre-existing city characteristics.

Our key coefficient of interest γ on the border$\times$division interaction is negative and highly statistically significant, consistent with the predictions of the theoretical model. Division leads to a reduction in the annualized rate of growth of the cities along the East-West German border relative to other West German cities of about 0.75 percentage points. This estimate implies a decline in the population of treatment cities relative to control cities over the 38 year period from 1950 to 1988 of around one third.

In Column (2) we augment our baseline specification and examine heterogeneity over time in the treatment effect of division. Instead of considering a single interaction term between the border dummy and a dummy for the period of division, we introduce separate interaction terms between the border dummy and individual years when Germany was divided. These interaction terms between division years and the border dummy are jointly highly statistically significant and their magnitude declines monotonically over time. After some thirty years, the size of the treatment effect falls by approximately 2/3 from 1.25 percentage points during 1950-60 to 0.40 percentage points during 1980-88, consistent with relative city size gradually adjusting towards a new long-run equilibrium.

In Column (3) we investigate heterogeneity in the treatment effect depending on distance from the East-West border. Instead of considering a single border measure based on a distance threshold of 75 kilometers, we introduce a series of dummies for cities lying within cells 25 kilometers wide at varying distances from the East-West German border ranging from 0-25 kilometers to 75-100 kilometers and their interactions with division. The estimated coefficients on the division interactions for 0-25 kilometers, 25-50 kilometers and 50-75 kilometers are negative and statistically significant, while the estimated coefficient on the interaction for 75-100 kilometers is positive but not statistically significant. Therefore, consistent with the predictions of the theoretical model, the negative treatment effect of division on the cities along the East-West German border cities is highly localized, with little evidence of any negative treatment effect beyond 75 kilometers from the East-West German border.

A somewhat surprising feature of the estimates in Column (3) is that the coefficient for the 0-25 kilometers grid cell is actually smaller than that for the 25-50 kilometers grid cell, though the difference is not statistically significant. From the simulation of the model, one would have expected a larger negative treatment effect for cities in the immediate vicinity of the new border. This pattern of results could be due to the operation of large-scale federal and state subsidy programmes for the East-West border region, which were disproportionately targeted at settlements in the immediate vicinity of the new border. The first formal statement of this policy is the Regional Policy Act of 1965 ("Raumordnungsgesetz 1965") which states the goal that economic development in the areas along the East-West border should be "at least as good as that in West Germany as a whole".[26] To the extent that these subsidy programmes were at least partially successful, they could explain

[26] Ziegler (1992) estimates that roughly half of all regional policy spending in West Germany during the 1970s and 1980s was allocated to the East-West border region. Evaluating the impact of these regional policy programmes is difficult, since regional policy spending is likely to be highly endogenous, with areas that are particularly hard-hit receiving more support.

the comparatively small treatment effect on cities within 25 kilometers of the East-West border, and imply that our estimates provide a lower bound to the negative treatment effect of division.

In Columns (4) and (5) we re-estimate our baseline specification for the sub-samples of cities with a population in 1919 below and above the median value for the future West Germany. While the estimated treatment effect is negative for both sub-samples of cities, the absolute magnitude of the negative treatment effect is larger and more precisely estimated for small cities. This provides strong evidence for the second key empirical prediction of the model that the treatment effect of division should be larger for small cities than for large cities.

To explore the robustness of the results presented in Table 2, we examined a number of alternative specifications and samples, which are discussed in detail in the web-based technical appendix. First, we augmented our baseline specification with state fixed effects or city fixed effects, excluded individual states ("Länder"), and excluded coastal cities that may depend less on market access within Germany. Second, a key advantage of our baseline sample is that it selects cities based on pre-treatment characteristics, but a potential disadvantage is that we examine a fixed number of cities and therefore abstract from the emergence of new cities. To explore the sensitivity of our results to the emergence of new cities, we re-estimated our baseline specification using all cities with at least 50,000 inhabitants in 2000. Third, to examine the sensitivity of the results to our aggregations of administrative cities, we re-estimated our baseline specification excluding cities involved in aggregations from the sample in all years, and also examined whether the probability of an aggregation occurring is correlated with the division treatment. Finally, we also explored the sensitivity of our results to excluding all city-year observations in which there are smaller changes in city boundaries that are not captured in our aggregations. Across all of these robustness checks, we find that the treatment effect of division is remarkably stable and does not depend on details of the estimation approach or the specific sample of cities.[27]

5.3. Non-parametric Estimates

In this section, we present the results of an alternative estimation strategy that enables us to estimate a separate division treatment for each city. We regress annualized population growth in West German cities on a full set of city fixed effects (η_i) and interactions between the city fixed

[27] One remaining concern is that city growth may may lead to suburbanization beyond the boundaries of the administrative city. As the group of control cities experienced substantial population growth during the division period, while the group of treatment cities approximately stagnated, control cities may have experienced greater suburbanization beyond their boundaries than treatment cities during the division period. To the extent that such differential suburbanization occurred, our estimates provide a lower bound to the treatment effect of division.

effects and the division dummy ($\eta_i \times Division_t$):

$$Popgrowth_{ct} = \sum_{i=1}^{N} \mu_i \eta_i + \sum_{i=1}^{N} \theta_i \left(\eta_i \times Division_t\right) + \omega_{ct} \tag{4}$$

where c and i index cities; N is the number of cities in our sample; η_i is a dummy which is equal to zero except for city i when it takes the value one; $Division_t$ is defined as above; μ_i and θ_i are coefficients to be estimated; and ω_{ct} is a stochastic error.

The coefficients μ_i on the city fixed effects capture mean population growth for individual cities during the pre-war period. The coefficients θ_i on the interaction terms between the city fixed effects and division capture the change in individual cities' mean rates of population growth between the pre-war and division periods. Figure 5 graphs the estimated values of the division treatments θ_i against distance from the East-West German border. For ease of interpretation, we have normalized the division treatments in the figure so that their mean value across cities is equal to zero.

While the non-parametric specification imposes no prior structure on how the estimated treatment effects for individual cities are related to distance from the East-West border, we nonetheless find a clear relationship. The estimated treatment effects for cities close to the East-West border are clustered below zero, implying that these cities experience a below average change in their population growth rates between the pre-war and division periods. Furthermore, the negative impact of division is highly localized, with the decline in relative population growth most evident within 75 kilometers of the East-West border, confirming the findings of the parametric estimation above.[28]

6. The Role of Market Access

The two main empirical findings so far – a decline in the relative population growth of West German cities along the East-West border and a greater relative decline in population growth for small than for large cities – are consistent with the two main predictions of our economic geography model. Furthermore, there is no straightforward explanation for these two findings in terms of the other leading theories for differences in comparative economic development, such as differences in institutions and natural endowments. As we are examining cities within the same country over time, there are no obvious differential changes in institutions or natural endowments between our

[28] The interaction terms between the city fixed effects and division are jointly highly statistically significant (p-value = 0.000). Furthermore, the average estimated division treatment within 75 kilometers of the East-West border is statistically significantly different from the average treatment across other West German cities, the average treatment between 75 kilometers and 150 kilometers from the border, the average treatment between 150 and 225 kilometers from the border, and the average treatment more than 225 kilometers from the border at conventional levels of statistical significance.

treatment and control cities that could be responsible for our findings.[29]

Nonetheless, there are other potential explanations that could at least partly account for our findings. First, the cities close to the new border could have disproportionately specialized in industries that experienced a secular decline during the post-war period (e.g. coal and other mining industries). Second, cities in the treatment and control groups could differ systematically in terms of the extent of destruction they suffered during the war or the number of war-related migrants they absorbed, which could have affected their relative population growth. Third, closer economic integration between West Germany and its EU trade partners could have raised the population growth of cities in the Western areas of West Germany and contributed to the relative decline of the cities close to the East-West border. Finally, fear of a further armed conflict in Western Europe could have motivated people to move away from the border with East Germany.

In the remainder of this section, we present several pieces of additional evidence that the decline of cities along the East-West German border is driven by their loss of market access, rather than by these alternative possible explanations.

6.1. Quantitative Analysis of the Model

We first demonstrate that the model can not only explain the qualitative pattern but also the quantitative magnitude of the decline of cities along the East-West German border relative to other West German cities. Rather than assuming values for the model's parameters from the existing literature, as in Section 3.3, we instead search for the parameter values for which the relative decline of the East-West German border cities in the simulation is closest to that observed in the data. We follow an approach similar to that used in quantitative macroeconomics and choose parameter values to minimize the distance between moments in the simulation and data. We find that there are plausible parameter values for which the model can explain the quantitative magnitude of the relative decline of the cities along the East-West German border, providing further evidence that their relative decline is indeed due to a loss of market access.

To compare moments in the simulation and data, we undertake a grid search over a wide range of possible values for the three parameters of the model relative to central estimates from the existing literature: an elasticity of substitution σ from 2.5 to 6.5, a share of expenditure on manufacturing μ from 0.65 to 0.85, and an elasticity of transport costs with respect to distance ϕ from 0.10 to 1.10.

[29] Our empirical findings also cannot be easily explained by models of stochastic city growth (see for example Simon 1955 and Gabaix 1999). If city development follows an independent stochastic process, the imposition of the East-West border has no clear effect on the relative population growth of West German cities close to and far from the new border.

We search over twenty-one values of each parameter within these ranges, yielding a total of 9,261 possible parameter configurations.[30] As we discuss below, the simulated decline of the East-West German border cities becomes substantially larger than the estimated decline as we approach the threshold for multiple equilibria, which is $\sigma(1-\mu)=1$ in the Helpman (1998) model. Therefore, as we can explain the quantitative decline of the cities along the East-West German border without having to invoke multiple equilibria, we focus on the 5,145 parameter configurations for which $\sigma(1-\mu)>1$ and the model has a unique stable equilibrium.

For each parameter configuration, we first calibrate the model to the 1939 distribution of population across cities in pre-war Germany, and then simulate the impact of division on the steady-state population of each West German city. To compare the quantitative predictions of the model with the results of our econometric estimation, we annualize the change in the steady-state population in the simulation over the 38-year period from 1950 to 1988. We therefore implicitly assume that by 1988 the population of West German cities had adjusted to the new steady-state following division, which appears a reasonable approximation based on the decline in the estimated magnitude of the division treatment over time evident in Figures 3 and 4 and Table 2.

Across the wide range of parameter values in the grid search, the mean simulated decline of cities along the East-West German border relative to other West German cities varies substantially. The relative decline across all cities in the simulation varies from zero for some parameter configurations to -1.265 percentage points per annum as one approaches the threshold for multiple equilibria, which is almost twice as large as our baseline econometric estimate of -0.746 percentage points per annum in Column (1) of Table 2. Similarly, the relative decline for small cities varies from zero to -1.500 percentage points per annum, while the relative decline for large cites varies from zero to -0.952 percentage points per annum, where small and large cities are defined as above.

As discussed below and in the web-based technical appendix, the quantitative predictions of the model for the relative decline of the East-West border cities after division depend only on the strength of agglomeration and dispersion forces $\sigma(1-\mu)$ and the coefficient on distance $(1-\sigma)\phi$. Therefore our data on the relative decline of the East-West border cities can only be used to determine the values of $\sigma(1-\mu)$ and $(1-\sigma)\phi$, but not the values of the individual parameters

[30] We implicitly assume that the parameters of the model, including the coefficient on distance $(1-\sigma)\phi$, are constant over time. While we could in principle allow for changes in parameters over time, we show below that the model can explain the quantitative decline of the border cities with time-invariant parameters. Furthermore, while secular reductions in transportation costs have increased trade at all distances, there is currently little evidence from the gravity equation literature in international trade of a decline in the coefficient on distance over time (see for example the recent meta-analysis in Disdier and Head 2007).

μ, σ and ϕ, as several values of these parameters are consistent with the same values of $\sigma(1-\mu)$ and $(1-\sigma)\phi$. To determine the value of these two key relationships of the model, we focus on the model's ability to explain our two main empirical findings. In particular, we compare the mean relative decline of small and large cities in the simulation against their relative decline in the econometric estimates in columns (4) and (5) of Table 2, which are -1.097 and -0.384 percentage points per annum respectively.

Figures A1 and A2 of the web-based technical appendix show the simulated division treatments for small and large cities as a function of the strength of agglomeration and dispersion forces $\sigma(1-\mu)$ and the coefficient on distance $(1-\sigma)\phi$. The figures display three-dimensional surfaces constructed through the discrete points of the parameter grid using triangle-based linear interpolation. The simulated division treatments for small and large cities in the figures are well-behaved in $\sigma(1-\mu)$ and $(1-\sigma)\phi$ space and vary intuitively with these two key relationships of the model. Figure 6 displays contours from the three-dimensional surfaces in Figures A1 and A2. Each contour shows combinations of the strength of agglomeration and dispersion forces $\sigma(1-\mu)$ and the coefficient on distance $(1-\sigma)\phi$ that yield the same value of the simulated division treatment for small and large cities respectively. Since the simulated division treatments for small and large cities are decreasing in $\sigma(1-\mu)$, and are greatest for intermediate values of $(1-\sigma)\phi$, the contours are concave to the distance axis. The contours shown in Figure 6 are for simulated division treatments for small and large cities equal to the estimated division treatments of -1.097 and -0.384 percentage points per annum respectively.

The small city contour in Figure 6 traces out alternative combinations of the strength of agglomeration and dispersion forces and the distance coefficient where the simulated division treatment is equal to the estimated division treatment for small cities. The large city contour displays the same information for large cities. In this figure, there is only one combination of the strength of agglomeration and dispersion forces and the distance coefficient where the simulated division treatment equals the estimated division treatment for *both* small and large cities, which is the point of intersection between the two contours. This point of intersection corresponds approximately to a strength of agglomeration and dispersion forces of 1.020 and a value of the distance coefficient of -1.580. The nearest point to the intersection of these contours on the discrete grid is a strength of agglomeration and dispersion forces of 1.015 and a value of the distance coefficient of -1.500, for which the simulated declines of small and large cities are equal to -1.060 and -0.449 percentage points per annum respectively.

Although the properties of the model depend only on the strength of agglomeration and dispersion forces and the distance coefficient, the values of $\sigma(1-\mu) = 1.015$ and $(1-\sigma)\phi = -1.500$ respectively are consistent with plausible values for the model's three underlying parameters. For example, these values for the model's two key relationships can be generated by parameter values of $\mu = 0.71$, $\sigma = 3.5$, and $\phi = 0.6$, which are not dissimilar from the central values from the existing literature used in Section 3.3 above.

The coefficient on distance can also be directly compared to estimates from the gravity equation literature. While a distance coefficient of around -1.5 is somewhat high for estimates in this literature using international trade data (as surveyed for example in Disdier and Head 2007), it is somewhat lower than the value of -1.76 estimated using contemporary trade data between French regions by Combes *et al.* (2005). One natural explanation for higher distance coefficients using intranational rather than international trade data is differences in transportation mode. Intranational trade, such as trade between German cities, is likely to rely more heavily on land rather than sea transportation, which is found by for example Limao and Venables (2001) to yield higher distance coefficients.

As a final illustration of the model's ability to quantitatively account for the decline of the cities along the East-West German border, Figure 7 plots the simulated change in population growth of each West German city against distance from the border. The simulation is based on values of the strength of agglomeration and dispersion forces of 1.015 and a coefficient on distance of -1.500. For comparison, the figure also includes the estimated change in population growth from the non-parametric estimates in Figure 5. For ease of interpretation both variables are normalized so that their mean across all West German cities is equal to zero. The standard model of economic geography that we are using is clearly stylized and can only plausibly be expected to explain tendencies in the data. There are many other idiosycratic factors that affect the population growth of individual cities, as apparent in Figure 7 from the much larger variance of the non-parametric estimates relative to the simulation results. Nonetheless, the figure shows a striking similarity in the relationship between population growth and distance from the East-West German border between the simulation and the actual data.[31]

[31] While our model follows the new economic geography literature in emphasizing market access as the source of agglomeration, Marshall (1920) also discusses knowledge spillovers and the pooling of specialized skills. These alternative sources of agglomeration are, however, generally believed to be substantially more important for interactions within cities than for interactions between cities such as those severed by German division (see for example Arzaghi and Henderson 2007). Furthermore, the ability of our model to closely fit the quantitative pattern of the decline of the border cities also points to a market access based explanation.

Overall, there is therefore considerable evidence that a market access-based explanation cannot only qualitatively but also quantitatively explain the relative decline of the West German cities along the East-West border after division.

6.2. City Structure

In this section, we provide evidence that differences in city structure are not driving our results by combining our difference in differences methodology with matching. In particular we match each treatment city within 75 kilometers of the East-West border to a control city that is more than 75 kilometers from this border and is as similar as possible to the treatment city in terms of its observed characteristics. Matching leads to a dramatic reduction in the sample size as we exclude all cities that are not matched with one of our twenty treatment cities. The counterbalancing advantage is that we compare the treatment cities to a group of control cities that are more similar in terms of their observed characteristics.

In Column (1) of Table 3 we match on population by minimizing the squared difference in 1939 population between treatment and control cities, as small cities may have systematically different economic structures from large cities. In Column (2) we match on 1939 employment levels, which controls for heterogeneity in the size of the workforce across cities. Column (3) addresses the concern that the treatment and control groups of cities could differ in their degree of specialization in industries that experienced a secular decline during the post-war period, such as coal and other mining industries. To address this concern, we compare treatment and control cities that are as similar as possible in terms of their employment levels across disaggregated industries by minimizing the sum of squared differences in 1939 employment across 28 sectors.[32] In Column (4) we take the specification from Column (3) and also require the set of control cities to lie within a band 100-175 kilometers from the East-West border. This ensures that the control group of cities is both similar in industrial structure and geographically close to the treatment group. It also has the advantage of excluding the Ruhr area from the control group, which further addresses the concern about differential specialization in coal and other mining industries, since the Ruhr area accounts for over 97 per cent of all mining employment in West Germany in our 1939 employment data.[33]

Across all four columns of Table 3, we find a negative and highly statistically significant co-

[32] The sectors are comparable to two-digit ISIC industries. See the data appendix for a list of the sectors. Matching on employment in disaggregated manufacturing industries alone yields a similar pattern of results.

[33] This approach complements our earlier robustness check of excluding individual states from our baseline specification in Table 2, where we find that excluding North Rhine-Westphalia which contains the entire Ruhr area yields a very similar pattern of results.

efficient on the border×division interaction, which is of the same magnitude as in our baseline specification. This provides powerful evidence of a strong negative treatment effect of division on East-West border cities after controlling for variation in city structure and geographical location. The similarity of the estimation results with and without matching is further evidence that the drawing of the border between East and West Germany was driven by military considerations unrelated to pre-existing city characteristics.

6.3. War Devastation and Refugees

To address the concern that differences in war-related disruption could explain the decline of the East-West border cities, we exploit our city-level data on rubble per capita, the percentage of the stock of dwellings destroyed, and German refugees from the former Eastern parts of Germany.

We begin by regressing the two destruction measures on the border dummy that is equal to one if the city is within 75 kilometers of the East-West German border. For both measures we find that East-West border cities experienced marginally less destruction, but the difference is not statistically significant at conventional levels.[34] To further explore a possible link between war-related destruction and the decline of the East-West border cities, Columns (1) and (2) of Table 4 estimate our baseline specification from Column (1) of Table 2, but include a full set of interactions between our measures of destruction and year dummies. This specification allows destruction during the Second World War to have different effects on city growth rates in different years and places no prior structure on the time period over which these effects operate.

The inclusion of the interactions between war-related destruction and year dummies has little impact on the estimated treatment effect of division on cities along the East-West German border. The treatment remains of the same magnitude and highly statistically significant, providing strong evidence that our results are not driven by differing levels of war damage between East-West border cities and other West German cities. In addition we find that cities which experienced heavier destruction during the Second World War grew more rapidly during the 1950s as rebuilding took place, but war-related destruction seems to have little effect on city growth thereafter. This finding is in line with the results of Davis and Weinstein (2002) and Brakman *et al.* (2004) that Japanese and West German cities recovered surprisingly fast from the damage done by Allied bombing attacks and returned to their pre-war growth trajectories.

[34]The regressions using rubble and destroyed dwellings have 111 and 108 observations respectively since the data are missing for a few cities. The estimated coefficients (*standard errors*) are -0.876 (*2.213*) and -8.940 (*5.961*) respectively.

To explore the impact of refugees from the former Eastern parts of Germany on West German city growth, we again first run a cross-section regression of our measure of refugees on the border dummy. We find that East-West border cities have a statistically significantly higher share of their 1961 population that originated in the former Eastern parts of Germany than other West German cities.[35] This is consistent with migration in the closing stages and immediate aftermath of the Second World War favouring West German destinations close to the former Eastern parts of Germany. In Column (3) of Table 4 we include a full set of interactions between our measure of refugees and year dummies in our baseline specification and again find that the treatment effect of division remains negative, statistically significant and of a similar magnitude.[36] Overall, the results suggest that differences in war-related disruption do not explain the decline of East-West border cities relative to other West German cities.

6.4. Western Integration

Another concern is that our estimates of the relative decline of the cities along the East-West German border could in part be explained by the increasing economic integration of West Germany into Western Europe. While Western European economic integration is hard to reconcile with the treatment effect's timing (stronger in the 1950s and 1960s than later) and highly localized nature (within 75 kilometers of the East-West German border) it could nevertheless have contributed to the relative improvement in the population growth of more Western cities in West Germany, particularly from the 1970s onwards.

To explore this possibility, Column (1) of Table 5 augments our baseline specification with a Western border dummy, which is equal to one if a city lies within 75 kilometers of the Western border of West Germany, and the interaction between this dummy and division. We find that cities close to the Western border of West Germany grew slightly faster following division, but this difference is not statistically significant. As a further robustness test, Column (2) of Table 5 augments the distance grid cells specification in Column (3) of Table 2 with similar distance grid cells based on proximity to the Western border of West Germany. In this specification, we find that distance cells closer to the Western border of West Germany exhibit a slightly more positive treatment effect, which is significant at the 10 percent level for the 25 to 50 kilometers grid cell.

[35] The estimated coefficient (*standard error*) are 5.168 (*2.017*).

[36] We have also simultaneously included both interactions between war-related destruction and year dummies and also interactions between refugees and year dummies in our baseline regression and find a very similar treatment effect also in this specification. Using rubble as the measure of war-related destruction, the estimated coefficient (*standard error*) for the division treatment are -0.739 (*0.196*).

In both specifications the treatment effect of division on the cities along the East-West German border remains of very similar magnitude and statistically significant.

This pattern of results suggests that Western economic integration involved a much smaller change in market access than German division and cannot explain the relative decline of the cities along the East-West German border.[37]

6.5. Fear of Further Armed Conflict

A final concern is that the decline of the cities along the East-West German border could at least in part be explained by a belief that these areas were particularly vulnerable in case of a new armed conflict in Western Europe. In this section we present a number of pieces of evidence which cast doubt on this alternative explanation.

First, political and military strategy made it extremely unlikely that a new armed conflict would remain localized in the vicinity of the East-West German border. Already in 1954 in an important public speech U.S. Secretary of State John Foster Dulles introduced the concept of "massive retaliation", which threatened an overwhelming nuclear response even to a conventional attack from Warsaw Pact forces. Such massive retaliation would have escalated into all out nuclear war, which would have devastated large parts of Western Europe.[38] Also the deployment of conventional forces was not tailored to a local conflict, since the bulk of Allied military installations were located in the West of West Germany (see, for example, Faringdon 1986).[39]

Second, opinion poll data casts doubt on the importance of fear of a further war as an everyday concern of the general public in West Germany. Noelle and Neumann (1956, p. 22), for example, report the results of a representative opinion poll in April 1954 in which 2000 respondents in West Germany and West Berlin were asked "Would you tell me what your most serious worries and difficulties are at the moment". Only three percent of respondents named "anxiety about a future war" as one of their answers, while 64 percent of all respondents pointed to "money troubles" or "worries in connection with work, job and unemployment". Similar polls in later years confirm this picture.

Third, there was a widely held belief that in the event of a conflict the ground forces of the

[37] This pattern of results is also in line with our results in Column (4) of Table 3, where we exclude cities more than 175 kilometers from the East-West border from the control group, and with the pattern of estimates apparent in the non-parametric results in Figure 5.

[38] See Bluth (2002), for example, for a recent discussion of NATO and Warsaw Pact strategy during the cold war.

[39] The Western location of allied military installations within West Germany also casts doubt on the related idea that the regions along the East-West German border became unattractive following division because of disamenities associated with military installations.

Warsaw Pact would attack through the Fulda Gap, which is an area of lower-lying land between mountainous regions around the West German town of Bad Hersfeld. We thus created a dummy variable which is equal to one for those East-West border cities whose distance to Bad Hersfeld is less than the median value for the 20 East-West border cities and zero otherwise, and include this dummy and its interaction with division in our baseline specification (3). In this augmented specification we find that East-West border cities closer to the Fulda Gap in fact declined slightly less during division, but the difference is not statistically significant.

Fourth, in centrally-planned East Germany the allocation of resources was determined by the priorities of the planning process, which are unlikely to mimic market forces. Consistent with this hypothesis, when we re-estimate our baseline specification (3) for East Germany, we find that cities close to the East-West border experience an increase in population growth relative to other East German cities following German division. This provides further evidence that the decline of the West German cities along the East-West border is driven by market forces, as emphasized in our model, rather than by other factors associated with being close to the East-West border.

Finally, our finding that small cities are disproportionately affected by the drawing of the East-West border is hard to reconcile with an explanation based on fear of further armed conflict. At least historically, large rather than small cities have had to bear the main brunt of war-related destruction. Furthermore, the ability of the model to quantitatively account for the decline of the East-West border cities casts doubt on the importance of alternative possible explanations.

In summary, all of the available evidence suggests that fear of a new armed conflict did not play an important role in explaining the decline of West German cities along the East-West border relative to other West German cities.

7. Reunification

We have so far presented a variety of evidence supporting division's negative impact on cities close to the East-West German border through market access. We now examine the effects of reunification, which was in many ways a much smaller experiment. First, the economic mass added to West Germany by reunification is substantially smaller, in terms of area, population and per capita income.[40] Second, since reunification East Germany has undergone a process of structural adjustment, which has involved the closing down of uncompetitive industries and high

[40] While East and West Germany had broadly similar level of income per capita prior to the Second World War (see for example Ritschl 1996), in 1990 GDP per capita in West Germany stood at $23,915 compared to $8,679 in East Germany (Lipschitz and McDonald 1990). See Sinn (2002) for a survey of progress towards convergence between East and West Germany since re-unification.

unemployment. Third, the substantial subsidies to the former border region were entirely phased out by the end of 1994, which may have partially offset the improvement in market access. Fourth, whereas division involved an abrupt severing of infrastructure and business links, the creation of such links following reunification is likely to be more gradual.

To investigate the impact of reunification Column (1) of Table 6 estimates our baseline specification from equation (3) for the division and reunification periods using annualized rates of population growth for the periods 1950-60, 1960-70, 1970-80, 1980-88 and 1992-2002. The estimated coefficient γ on the border$\times$division interaction is negative and highly statistically significant, implying that population growth was slower in East-West border cities relative to other West German cities during the period of division than after reunification. While this finding is consistent with an improvement in market access following reunification, the specification implicitly assumes that the East-West border cities have already adjusted to the impact of division, which is clearly invalid during most of the division period.

To mitigate this problem, Column (2) to (4) of Table 6 restricts the sample prior to reunification to 1980-88. With this more plausible, but much shorter, comparison period we again find a negative coefficient γ on the border$\times$division interaction, and Columns (3) and (4) show that this effect is again larger for small cities. However, the estimated coefficients are substantially smaller in magnitude than for division and are not statistically significant at conventional levels. This pattern of estimates is consistent with the much smaller change in market access caused by reunification, and we expect the recovery of the East-West border cities to become more substantial as convergence between East and West Germany progresses over the coming decades.

8. Conclusion

This paper exploits the division of Germany after the Second World War and the reunification of East and West Germany in 1990 as a natural experiment to provide evidence for the importance of market access for economic development. Following division West German cities close to the new border with East Germany went from being at the centre of an integrated Germany to being on the periphery of West Germany. In line with a standard new economic geography model, we show that the imposition of the East-West border led to a sharp decline in population growth in West German cities close to the new border relative to other West German cities, and that this decline was more pronounced for small cities than for large cities. We show that the model can explain the quantitative as well as the qualitative decline of the East-West border cities and provide a variety of additional evidence that our results are capturing a loss of market access rather than alternative possible explanations. Taken together, we provide evidence that there is not only an association but also a causal relationship between market access and the spatial distribution of economic activity.

A Data Appendix

The data on city populations were collected from the statistical yearbooks of pre-war Germany ("Statistisches Jahrbuch für das Deutsche Reich") and West Germany ("Statistisches Jahrbuch für die Bundesrepublik Deutschland"). Information on the latitude and longitude of West and East German cities was obtained from the German Federal Agency for Cartography and Geodesy ("Bundesamt für Kartographie und Geodäsie") and the webpage http://www.jewishgen.org/ShtetlSeeker/ for cities which are now part of Poland and Russia.

Data on both total employment in each city in 1939 and also total employment in each city disaggregated into 28 sectors was taken from the 1939 population census in Germany as reported in Statistisches Reichsamt (1941). The 28 disaggregated sectors are comparable to modern two-digit classifications: Agriculture, Mining, Minerals, Steel, Chemicals, Textiles, Paper, Print, Leather, Wood, Food, Apparel, Shoes, Construction, Utilities, Business Services, Transport, Restaurants, Public Administration, Education, Clerical, Consulting, Medical, Veterinary, Cosmetics, Entertainment, Domestic Help, and Other Support Worker.

Our two measures of war devastation are taken from Kästner (1949), who reports the results of a survey undertaken by the German Association of Cities ("Deutscher Städtetag"), as published in the "Statistisches Jahrbuch Deutscher Gemeinden". Our refugees measure is the share of each West German city's population that identified themselves as originating from the former Eastern parts of Germany in the 1961 census, as also reported in the "Statistisches Jahrbuch Deutscher Gemeinden".

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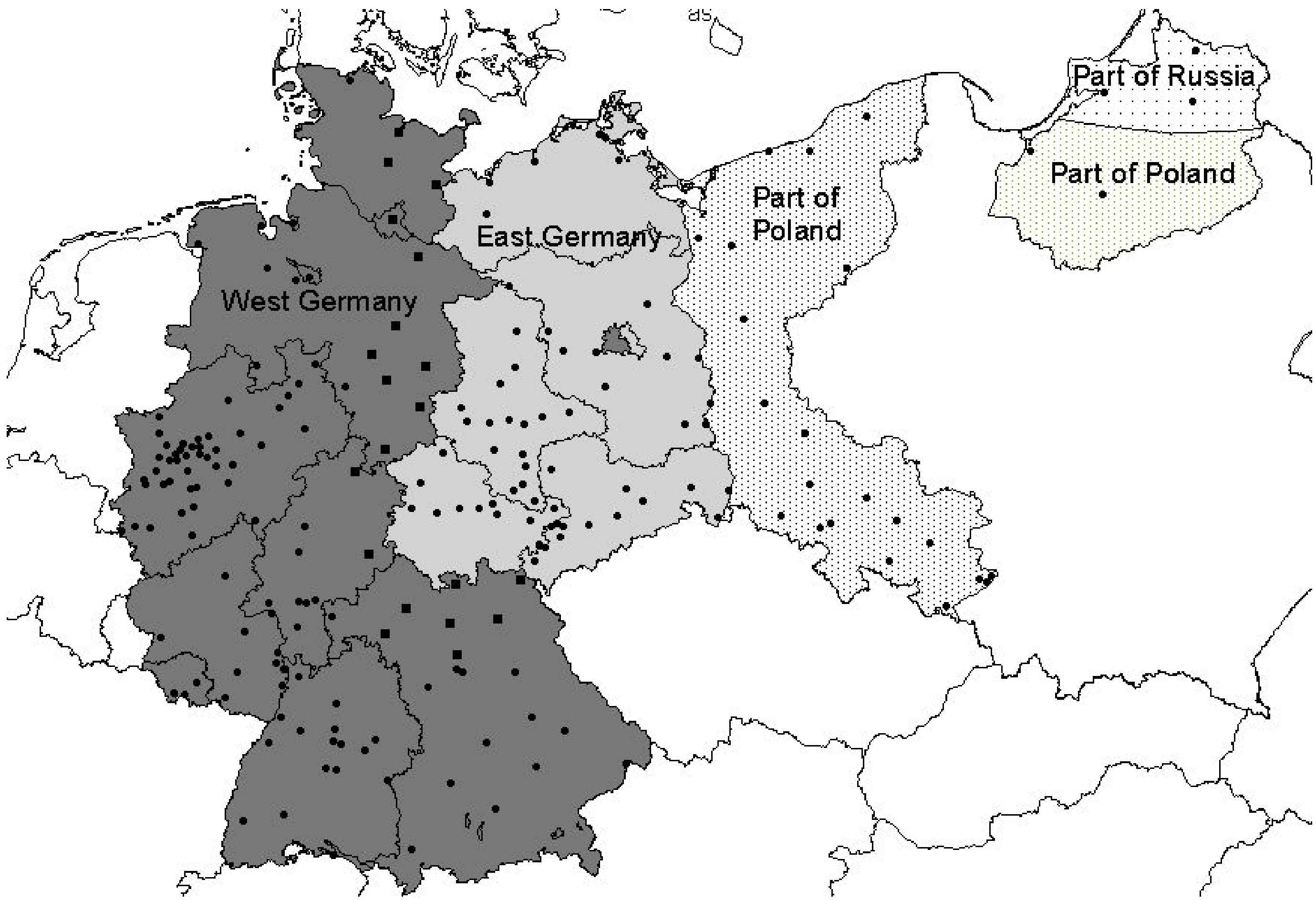
Map 1: The Division of Germany after the Second World War



Notes: The map shows Germany in its borders prior to the Second World War (usually referred to as the 1937 borders) and the division of Germany into an area that became part of Russia, an area that became part of Poland, East Germany and West Germany. The West German cities in our sample which were within 75 kilometers of the East-West German border are denoted by squares, all other cities by circles.

Figure 1: Simulated Change in West German City Population

By distance in km from the East−West Border

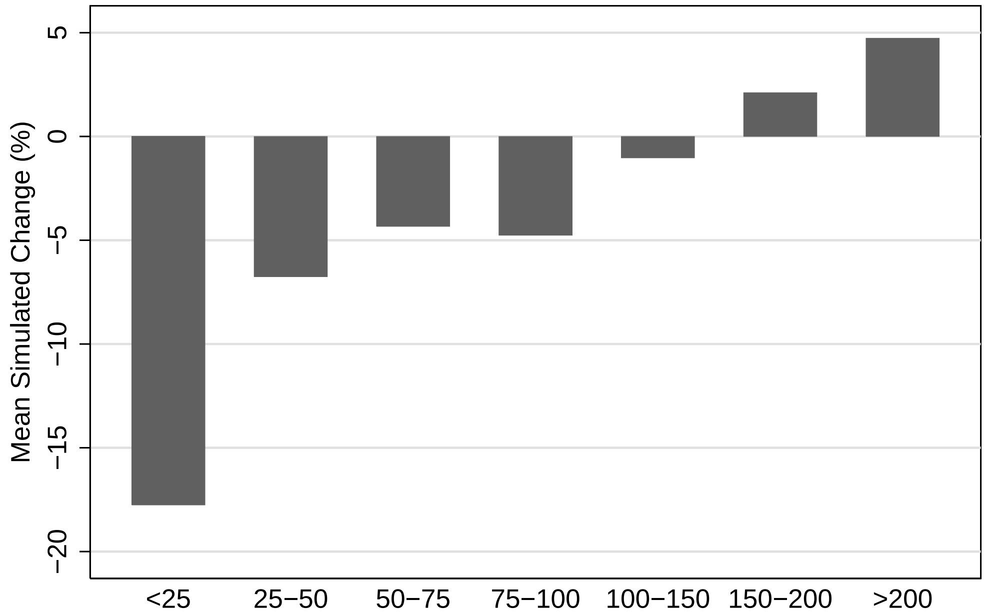


Figure 2: Differences in Simulated Population Changes

within and beyond 75km of E−W border for small and large West German cities

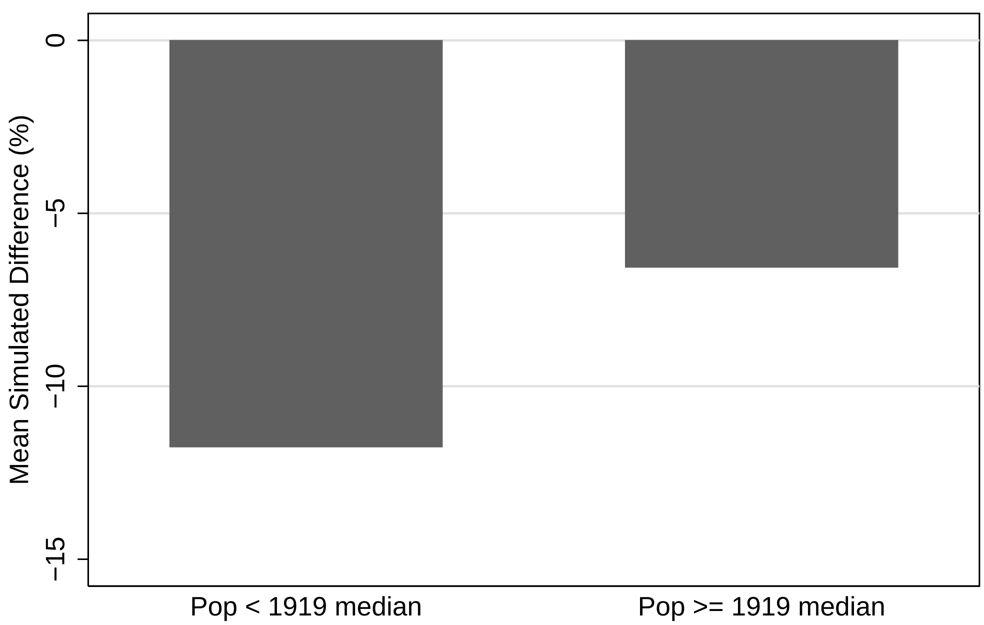


Figure 3: Indices of Treatment & Control City Population

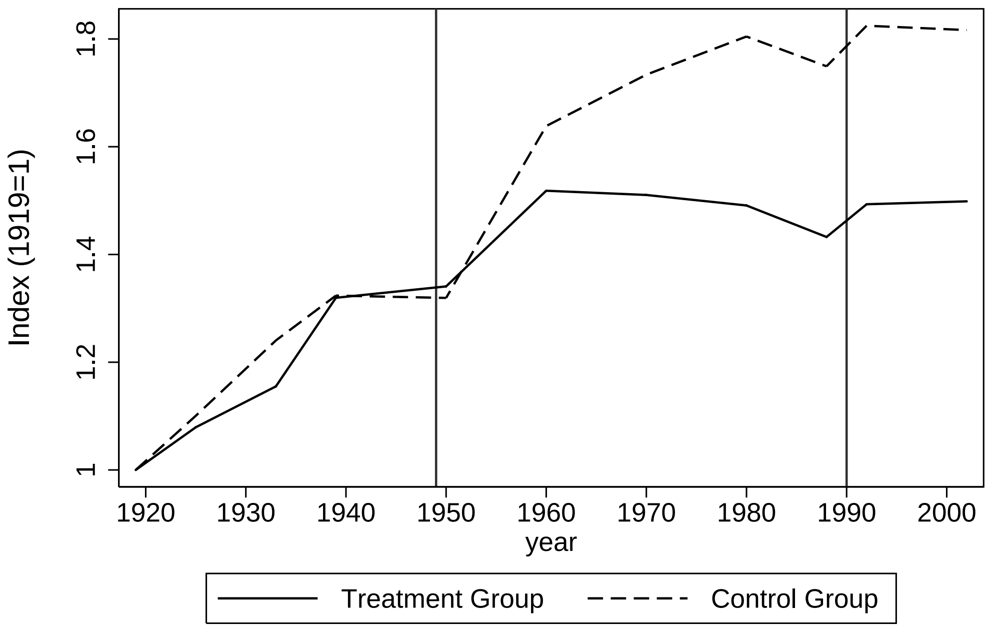


Figure 4: Difference in Population Indices, Treatment − Control

Figure 5: Non−parametric Division Treatment Estimates

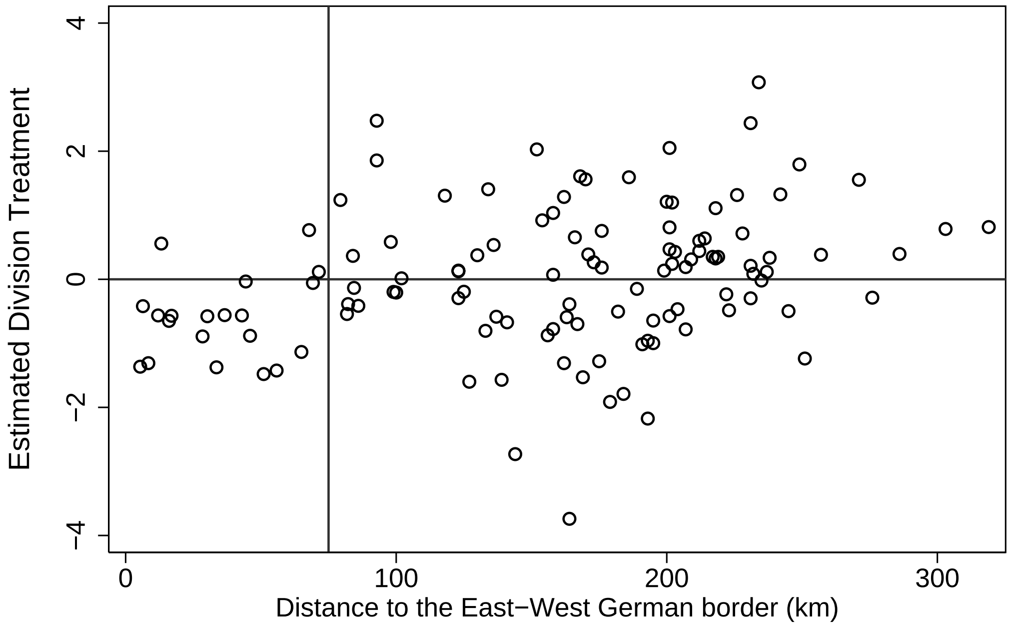


Figure 6: Contours of the Simulated Division Treatment

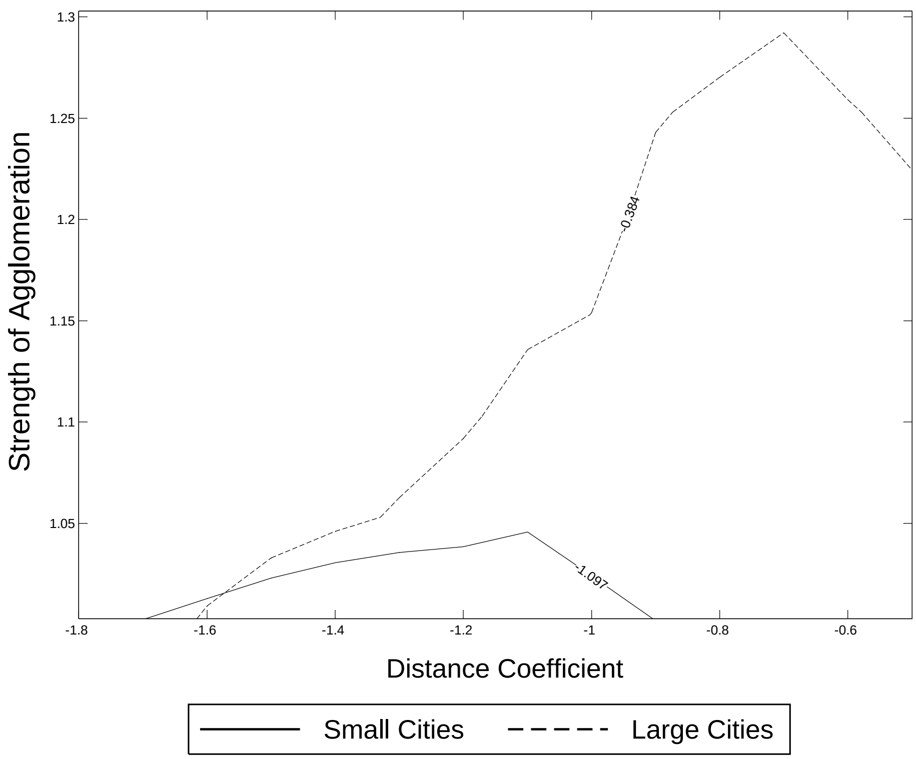


Figure 7: Simulated and Estimated Division Treatments

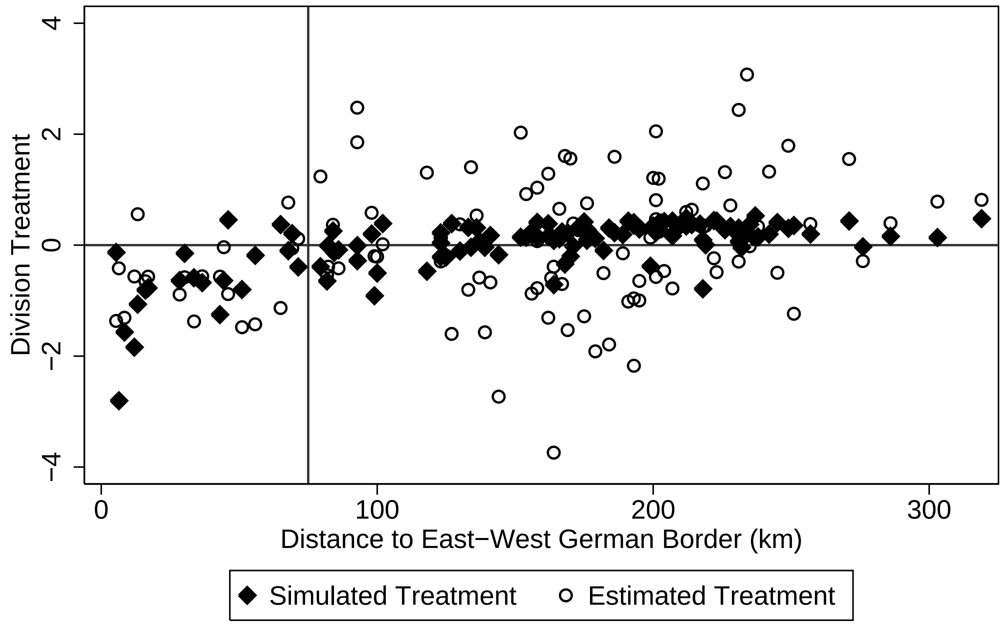


Table 1 − Treatment Group of Border Cities

Bamberg	Hannover
Bayreuth	Hildesheim
Braunschweig	Hof
Celle	Kassel
Coburg	Kiel
Erlangen	Lübeck
Fulda	Lüneburg
Göttingen	Neumünster
Goslar	Schweinfurt
Hamburg	Würzburg

Notes: The treatment group of twenty West German cities that lie within 75 kilometers of the East-West German border.

Table 2 - Basic Results on the Impact of Division

	Population Growth (1)	Population Growth (2)	Population Growth (3)	Population Growth (4)	Population Growth (5)
Border × Division	-0.746***			-1.097***	-0.384
	(0.182)			(0.260)	(0.252)
Border × Year 1950-60		-1.249***			
		(0.348)			
Border × Year 1960-70		-0.699**			
		(0.283)			
Border × Year 1970-80		-0.640*			
		(0.355)			
Border × Year 1980-88		-0.397***			
		(0.147)			
Border 0-25km × Division			-0.702***		
			(0.257)		
Border 25-50km × Division			-0.783***		
			(0.189)		
Border 50-75km × Division			-0.620*		
			(0.374)		
Border 75-100km × Division			0.399		
			(0.341)		
Border 0-25km			-0.110		
			(0.185)		
Border 25-50km			0.144		
			(0.170)		
Border 50-75km			0.289		
			(0.272)		
Border 75-100km			-0.299*		
			(0.160)		
Border	0.129	0.129		0.233	-0.009
	(0.139)	(0.139)		(0.215)	(0.148)
Year Effects	Yes	Yes	Yes	Yes	Yes
City Sample	All Cities	All Cities	All Cities	Small Cities	Large Cities
Observations	833	833	833	420	413
R-squared	0.21	0.21	0.21	0.23	0.30

Notes: Data are a panel of 119 West German cities. The left-hand side variable is the annualized rate of growth of city population, expressed as a percentage. Population growth rates are for 1919-25, 1925-33, 1933-39, 1950-60, 1960-70, 1970-80 and 1980-88. Border is a dummy which is 0 unless a city lies within 75 kilometers of the East-West German border in which case it takes the value 1. Division is a dummy which is 0 except for the years 1950-88 when German was divided in which case it takes the value 1. Border 0-25km is a dummy which is 0 unless a city lies within 25 kilometers of the East-West German border in which case it takes the value 1. Border 25-50km, Border 50-75km and Border 75-100km are defined analogously. Columns (4) and (5) report results for small and large cities, defined as those with a 1919 population below or above the median for the future West Germany. Standard errors are heteroscedasticity robust and adjusted for clustering on city. * denotes significance at the 10% level; ** denotes significance at the 5% level; *** denotes significance at the 1% level.

Table 3 − Matching

	Population Growth (1)	Population Growth (2)	Population Growth (3)	Population Growth (4)
Border × Division	-0.921***	-1.000***	-0.888***	-0.782***
	(0.218)	(0.253)	(0.247)	(0.261)
Border	0.309*	0.338**	0.082	0.061
	(0.153)	(0.156)	(0.167)	(0.194)
Year Effects	Yes	Yes	Yes	Yes
Matching on	Population	Total Employment	Employment in 28 sectors	Employment in 28 sectors and geography
Observations	280	280	280	280
R-squared	0.29	0.26	0.38	0.29

Notes: The dependent variable and explanatory variables are the same as in Table 2. We match each of the 20 treatment cities within 75 kilometers of the East-West German border to a control city more than 75 kilometers from the East-West German border that is as similar as possible in terms of various 1939 characteristics. In Column (1) we match based on the total 1939 population. In Column (2) the matching is based on total 1939 employment. In Column (3) the matching is based on minimizing the sum of squared 1939 employment differences in 28 sectors. In Column (4) we take the specification from Column (3) and also require the set of control cities to lie within a band 100-175 kilometers from the East-West border. Standard errors are heteroscedasticity robust and adjusted for clustering on city. * denotes significance at the 10% level; ** denotes significance at the 5% level; *** denotes significance at the 1% level.

Table 4 - Controlling for War Devastation

	Population Growth (1)	Population Growth (2)	Population Growth (3)
Border × Division	-0.737***	-0.656***	-0.678***
	(0.182)	(0.191)	(0.211)
Border	0.136	0.129	0.029
	(0.139)	(0.146)	(0.167)
War Disruption × Year 1919-25	-0.014	-0.004	0.004
	(0.011)	(0.006)	(0.020)
War Disruption × Year 1925-33	0.019	0.006	-0.018
	(0.017)	(0.007)	(0.019)
War Disruption × Year 1933-39	-0.001	0.004	0.064**
	(0.023)	(0.009)	(0.028)
War Disruption × Year 1950-60	0.073***	0.033***	-0.056**
	(0.015)	(0.008)	(0.026)
War Disruption × Year 1960-70	0.012	0.009	-0.006
	(0.017)	(0.007)	(0.026)
War Disruption × Year 1970-80	-0.014	0.004	0.062*
	(0.025)	(0.012)	(0.034)
War Disruption × Year 1980-88	0.007	0.002	0.009
	(0.013)	(0.006)	(0.020)
Year Effects	Yes	Yes	Yes
War Disruption Measure	Rubble	Dwellings	Refugees
Observations	777	756	833
R-squared	0.24	0.24	0.24

Notes: In Column (1) war devastation is measured as cubic meters of rubble per capita. In Column (2) war devastation is the number of destroyed dwellings as a percentage of the 1939 stock of dwellings. In Column (3) it is measured as the percentage of a cities population which are refugees from the former Eastern parts of Germany in 1961. The dependent variable and all other variables are defined as in Table 2. The rubble and destroyed dwellings measures are missing for a few cities which accounts for the smaller number of observations in Columns (1) and (2). Standard errors are heteroscedasticity robust and adjusted for clustering on city. * denotes significance at the 10% level; ** denotes significance at the 5% level; *** denotes significance at the 1% level.

Table 5 - Controlling for Western Economic Integration

	Population Growth (1)	Population Growth (2)
Border × Division	-0.730***	
	(0.204)	
Border	0.045	
	(0.151)	
Western Border × Division	0.032	
	(0.226)	
Western Border	-0.162	
	(0.152)	
Border 0-25km × Division		-0.675**
		(0.297)
Border 25-50km × Division		-0.756***
		(0.240)
Border 50-75km × Division		-0.593
		(0.403)
Border 75-100km × Division		0.426
		(0.372)
Western Border 0-25km × Division		0.421
		(0.383)
Western Border 25-50km × Division		0.488*
		(0.289)
Western Border 50-75km × Division		-0.375
		(0.338)
Western Border 75-100km × Division		-0.140
		(0.351)
Border Distance Grid Cells		Yes
Western Border Distance Grid Cells		Yes
Year Effects	Yes	Yes
Observations	833	833
R-squared	0.21	0.23

Notes: The dependent variable and sample are the same as in Table 2. Western Border is equal to one if a city lies within 75 kilometers of the Western border of West Germany and zero otherwise. Western Border 0-25km is equal to one if a city lies within 25 kilometers of the Western border of West Germany and zero otherwise. Western Border 25-50km, Western Border 50-75km, and Western Border 75-100km are defined analogously. All other variables are defined as in Table 2. Standard errors are heteroscedasticity robust and adjusted for clustering on city. * denotes significance at the 10% level; ** denotes significance at the 5% level; *** denotes significance at the 1% level.

Table 6 - The Impact of Reunification

	Population Growth (1)	Population Growth (2)	Population Growth (3)	Population Growth (4)
Border × Division	-0.477***	-0.127	-0.223	-0.007
	(0.156)	(0.128)	(0.202)	(0.136)
Border	-0.141	-0.141	-0.236	-0.064
	(0.106)	(0.106)	(0.168)	(0.108)
Year Effects	Yes	Yes	Yes	Yes
City Sample	All	All	Small Cities	Large Cities
Year Sample	1950-1988 & 1992-2002	1980-1988 & 1992-2002	1980-1988 & 1992-2002	1980-1988 & 1992-2002
Observations	595	238	120	118
R-squared	0.30	0.15	0.21	0.14

Notes: The dependent variable and explanatory variables are defined as in Table 2. In Column (1) population growth rates are for 1950-60, 1960-70, 1970-80, 1980-88, and 1992-2002. In Columns (2) to (4) population growth rates are for 1980-88 and 1992-2002. Column (3) and (4) reports results for small and large cities defined as those with a 1919 population below or above the median for the future West Germany respectively. Standard errors are heteroscedasticity robust and adjusted for clustering on city. * denotes significance at the 10% level; ** denotes significance at the 5% level; *** denotes significance at the 1% level.