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The East-West Gradient in Spatial Population Development within Germany: Temporary GDR Legacy vs. Longstanding Spatial Disparities

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The East-West Gradient in Spatial Population Development within Germany: Temporary GDR Legacy vs. Longstanding Spatial Disparities

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Abstract

Since the unification of Germany in 1990, the former communist eastern part of the country has experienced substantial levels of population decline and outmigration. These trends are largely attributable to East-West differences in economic development (Mai 2007). In this article, we explore the question of whether the recent decline in population is a temporary phenomenon related to the period of transition, or whether long-term geographical factors also affect spatial population trends in Germany. In particular, we investigate to what extent East-West differences are related to the fact that parts of western Germany belong to the *European dorsal* (or Blue Banana arc), which has long been the most important area of economic activity in Europe (Brunet 1989). Our findings show that an East-West gradient in spatial population trends has existed since the late 19th century. This suggests that long-term geographical factors are relevant for understanding trends in Germany's spatial population development.

Keywords: European Integration, German Division, Population Development, Spatial Variation, Germany

Past and Present Spatial Disparities in Livelihood Opportunities in Germany[1]

Over the last 20 years, East-West differences in livelihood opportunities, and the East-West migration patterns that resulted from these differences, have been central topics in research on internal migration in Germany (Wolff 2006; Mai 2007; Schlömer 2009). Recently, East-West migration flows have become less intense (Fuchs-Schündeln and Schündeln 2009), in part because of improving economic conditions in the East. Demographic factors have also influenced migration patterns. Currently in eastern Germany, the relatively large cohorts who were born after World War II are reaching retirement age, while the very small cohorts who were born after 1990 are entering the labor market. These smaller cohort sizes are likely to improve job market opportunities for young adults in eastern Germany[2]. Does this imply that, as the legacy of the GDR fades, a new paradigm in spatial population trends will emerge in Germany?

Some authors have argued that we might see a return to the North-South migration pattern (Kemper 2003) that was dominant in West Germany in the 1970s and 1980s (Sinz 1988; BMRBS 1990). This pattern resulted from differences in economic conditions and weak location factors. As most of the heavy industries, such as mining, iron and steel production, and shipbuilding, are concentrated in northern Germany, the North was hit harder by the crises in these sectors that started in the 1960s. Southern Germany, on the other hand, has a more mixed economic structure, with an industrial sector focused on machine-building and high-tech industries. As knowledge becomes increasingly important as an economic production factor, the South could also benefit from its traditional emphasis on education and its high density of universities.

However, we know from research on spatial population trends in the German Empire that there were quite significant population flows from the eastern to the western parts of the country before 1945 (Kirsten et al. 1966). A longstanding factor that may have influenced these trends is the proximity of these regions to important European centers of economic activity. Brunet (1989) has pointed out that substantial parts of western Germany belong to the so-called *European dorsal*, an arc stretching from southeastern England across the Benelux countries and the Rhine area to the regions north and south of the

Alps (highlighted in Figure 1). Due to its shape, it is also referred to as the "Blue Banana." This zone is characterized by high levels of economic development and population density. It was already discernible in 1870, and has since grown in significance (Martí-Henneberg 2005).

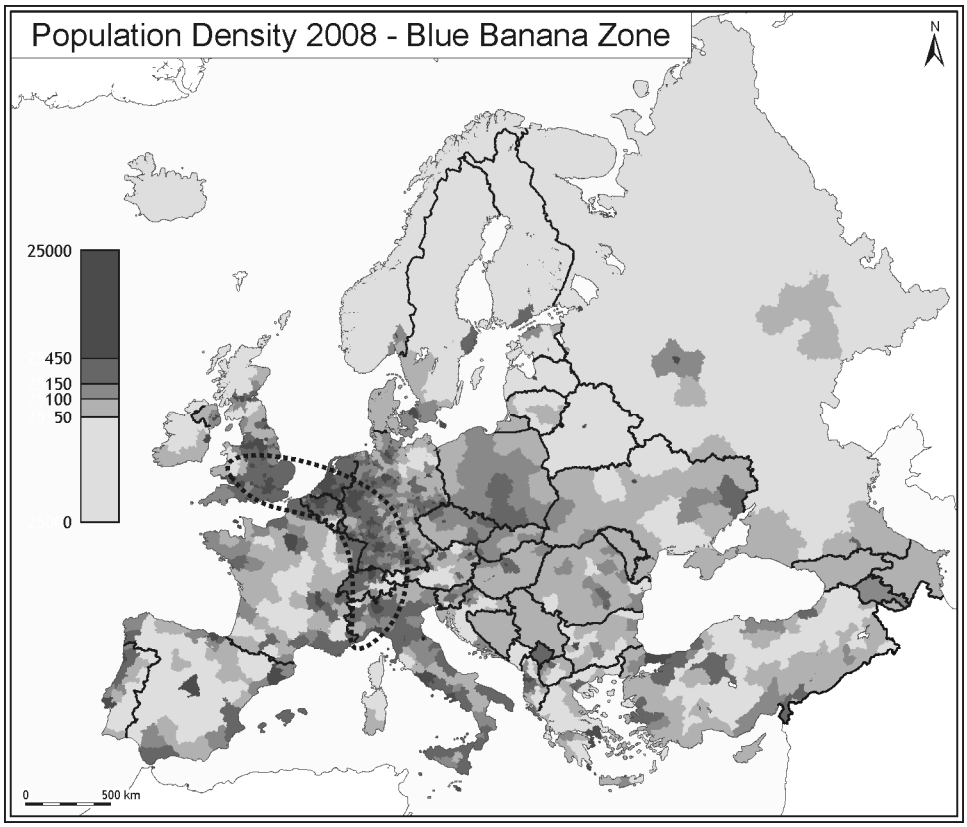

FIG. 1–Blue Banana zone is indicated by the dotted-lined area. *Source*: Eurostat, Statistical Offices, own calculations. *Base Map*: MPIDR & CGG; partly based on © EuroGeographics for the administrative boundaries. (Cartography by author)

The main aim of this paper is to investigate whether the East-West gradient in spatial population development over the last 20 years can primarily be explained by the recent legacy of the GDR, or whether it is also related to the fact that parts of western Germany are located within the Blue Banana zone. A finding that the gap between East and West is in part attributable to long-term trends would be relevant for future projections of regional population development in Germany. In our analysis, we are faced with the complication that Central Europe was heavily affected by war and the movement of refugees during the first half of the 20th century, as well as by a period of tight border controls during the Cold War. We therefore take a long-term view when analyzing data for the small-scale spatial population distribution for

Germany over the period 1855-2008. This also allows us to cover periods with no warfare activities and low restrictions on the freedom of movement, which are particularly suitable for analyzing the relevance of longstanding spatial disparities for spatial variation in population development (e.g., 1885-1910). Recent advances in the development of small-scale historical GIS on the administrative division of Germany (MPIDR 2011) enable us to analyze for the first time fine-gridded district-level data.

Theoretically, our study is based on the work of Myrdal (1957), Buttler et al. (1977) and Krugman (1991), who developed concepts and models that make it possible for us to explain why it is that, within a country or region, spatial disparities in economic development and livelihood opportunities are likely to increase rather than decrease over time, even under free market conditions. This phenomenon may, for example, be caused by spill-over effects in the centers of economic activity and selective migration of highly qualified people into those regions (see also *Greenwood* 1975).

But pure economic theories would probably fall short in explaining the observed spatial pattern of population change. Migratory decisions, which are currently the main cause of spatial disparities in spatial population trends, are not just an effect of differences in job opportunities between the current place of residence and a potential migration destination. Social capital considerations, such as the embeddedness in social kin and non-kin networks, both at the place of residence as well as at potential migration destinations, also play an important role (see, e.g., Massey et al. 1993; Haug 2000). These factors should be taken into consideration as well, as they may help us to explain why it is that, despite persisting spatial disparities in economic development in Germany, we do not see massive internal migration flows from economically disadvantaged areas (e.g., eastern Germany) to more prosperous ones (e.g., southern Germany).

Data and Methods

The German population data are predominantly derived from official statistical publications of Germany, the German Democratic Republic, the German Empire, and from publications of member states of these entities. We used data from a secondary source for 1855 only (Viebahn 1858). We sought to col-

lect data from census years in order to minimize problems due to the under-registration of migration events. Under-registration can create substantial errors at the district level (our main unit of analysis), especially as more time has passed since the last census.

Our source of geographic data on the administrative borders of the districts is the MPIDR Population History GIS Collection (MPIDR et al. 2011). This collection provides a time series of the administrative division of Germany with annual cross-sections from 1815 until today. A standardized division at the district level[3] is available from 1871 onwards, while for the period 1815-1871, the geographical detail of the administrative division varies by member state of the German Union.

The data for Germany are complemented with population data for large parts of Europe at the regional level, for the period 1870 until today. This allows us to place the population trends within Germany in a broader European context. As Germany is located at the center of the continent, it is likely to be affected by population trends in neighboring countries and regions. The regional administrative division of the European countries is similar to the division used by the Princeton European Fertility Project (Coale and Watkins 1986). Population data for the European states were derived in part from official sources and secondary sources, such as *Populstat*. The shapefiles for Europe come from the MPIDR Population History GIS collection (*MPIDR* et al. 2011). These were partly based on a 2003 shapefile of the administrative boundaries of Europe from EuroGeographics (2006).

Data for Germany at the district level are available for the following cross-sections: 1855, 1885, 1910, 1925, 1939, 1950, 1964, 1970, 1980, 1987, 1991, 1996, 2001, and 2008. The earliest cross-section of 1855 is from a period prior to the unification of Germany in 1870/71. At that time, the industrialization process was still in its early stages in Germany, and most of the population was living in rural settlements. The census of 1885 was, by contrast, carried out during a period of rapid urbanization and economic development. The census of 1910 was the last conducted before World War I, a conflict that had severe political and economic implications for Germany. The census of 1925 was taken between the hyperinflation of 1923 and the Great

Depression during the late 1920s. The census of 1939 was the last taken before World War II and the division of Germany into two countries.

Data from 1950 come from the first censuses that were carried out after the founding of the two German states, while 1964 marked the year of the second census of the German Democratic Republic. It was conducted shortly after the construction of the Berlin Wall, which greatly restricted migration streams. From 1961 until 1989, opportunities for East Germans to migrate to West Germany were very limited. The year 1970 was important for West Germany, as around that time the North-South migration pattern started to emerge. The last censuses prior to unification were taken in 1980 in East Germany and in 1987 in West Germany. The years 1991, 1996, 2001, and 2008 are the only cross-sections in our observation period of 150 years that are not close to any preceding country-wide censuses. This is because between the censuses of 1980 (East Germany) and 1987 (West Germany) and the recent enumeration of 2011, no population censuses were carried out in Germany. The four most recent cross-sections are probably the most problematic in terms of data quality, especially given the massive internal migration flows that took place in Germany after 1989.

In addition to the time series at the district level, we also obtained time series for the states and provinces of the German Empire, which cover the administrative division of 1934 for the period 1815-1933 (Statistisches Reichsamt 1936). These data allow us to study large-scale population trends from the end of the Napoleonic period onwards, and will also be used for our regional projections based on historical trends. For the European regions, we have data for the following cross-sections: 1870, 1930, and 2008. These data enable us to display the spatial distribution and trends for the period prior to World War II, and for the period 1930-2008.

Creation of a Dataset of Spatial Units with Time-Constant Areas

One of the main challenges we faced in our research is that Germany underwent a large number of reforms in the administrative division of its territory. While, for example, the cross-section of 1885 consists of around 785 districts or district-like sub-areas (within the area of present-day Germany), the number of districts had increased to around 870 in 1925 (this includes seven districts

in the Saar area), and then decreased to 413 in 2008. In addition to the frequent creation and elimination of districts, there have been hundreds of border changes. These reforms present problems for our analysis of spatial population distribution trends using fine-gridded data, as statistical methods can be very sensitive to changes in the total number of regions. This is generally referred to as *modifiable areal unit problem* (Openshaw 1983). We therefore decided to apply an estimation procedure to obtain a dataset with regions of time-constant area for the period 1855-2008.

In order to derive the dataset for our analysis, we used an *areal interpolation* procedure based on *areal weighting* (Goodchild and Lam 1980). This method is based on the assumption that the population is homogenously distributed within the so-called *source regions* for which data are available. This is a strong assumption, as it is unlikely that the population is homogenously distributed across space. However, for the purposes of our study we are only interested in the large-scale dimension of spatial population development, which means that it is not problematic if our estimation procedure dislocated some segments of the population by a small number of kilometers. We therefore deemed this rather crude approach to be suitable for our research purposes, and decided not to use more complex estimation methods, such as the EM algorithm (see Gregory 2002).

In order to derive the estimates, we applied a spatial intersection in which a GIS polygon file with border and area information on the source regions was intersected with one of the target regions. We thus obtained a GIS dataset with the smallest common polygons, which enabled us to reconstruct the target regions. We then computed estimates for the target regions based on the following formula:

$$\hat{y}_t = \sum_s \frac{A_{st}}{A_s} y_s$$

where $\hat{y}_t$ denotes the population estimate for the target regions, while y_s are the population counts reported in the source regions. A_s denotes the area of the source region, and A_{st} denotes the area of the zone where the source and target regions intersect (Goodchild and Lam 1980). For Germany, we used the districts that existed in 2008 as target regions. For Europe, we had to address the

problem that the cross-section of 1870 covers a smaller area of Europe than the cross-sections of 1930 and 2008. We therefore decided to use the 1870 regions as target regions, as this approach ensures that data from a source region is available for the whole area of each target region.

Methods

Our analysis is based on descriptive statistics, cartographic representations, and projections based on historical trends. One of the main challenges we faced was the allocation of people to time-constant areas. Our original dataset, generated with areal interpolation is biased at small scales. To address this problem, we used a spatial smoothing parameter, which smoothes out the small-scale fluctuations. As a result, we obtained a dataset that is appropriate for the broader geographic scales that we consider in this article. More specifically, we used the population potential measure, which determines how many people are living near a given point (Stewart and Warntz 1958; Rich 1980; Breßler 2001). We calculated the population potential for the centroids of the time-constant districts. In its general form, the population potential is based on the following formula:

$$V_i = \sum^{n} \frac{P_{i,j}}{D_{ij}^{\ b}}$$

where V_i is the population potential of district i; $P_{i,j}$ denotes the total population in district i and any other district j in the sample; and D_{ij} is the distance between the centroids of district i and district j. In this formula, b serves as our spatial smoothing parameter. The smaller b is, the more smoothed the resulting map. Using the population potential, we take the population of all districts in Germany into account, including i itself. For district i, we define a minimum distance D_o, as D has to be bigger than 0. This is derived using the following equation:

$$D_o = \sqrt{\frac{\sum_{i=1}^{n} A_i}{n * \pi}}$$

In this equation, A denotes the area in square kilometers. This minimum distance ensures that we also take the population in place i into account,

and that our equations are solvable. It is important to note that, in deriving the population potential, population outside the borders of Germany is not considered. Therefore there may be some boundary effects.

For our projections based on historical time trends, we tested a large number of ARIMA models for each of our four German macro-regions (see Figure 2), and selected the optimal model based on the Akaike Information Criterion. This procedure produced qualitative results similar to a choice of ARIMA (1,1,0), which implies that the differences in the series were regressed against the differences one period before. In other words, the linear trends were extrapolated into the future.

Long-Term Trends in the Spatial Population Distribution in Germany

Before turning to the analysis of the district-level data, we will first look at the macro-regional long-term population trends since 1816. The data up to 1933 were taken from a publication of the Statistical Office of the German Empire (Statistisches Reichsamt 1936) that contains population time series for units of time-constant areas covering the period 1816[4]-1933, based on the administrative division that existed in 1934. For 1939 onwards, we used data published by the Statistical Offices of West and East Germany, which included retrospective estimates of population values for 1939 for the administrative division that existed after the war.

For the population trends displayed in Figure 2, we divided Germany at the level of the current states (*Bundesländer*) into four-macro regions, shown on the map of Figure 2: North, West, East, and South. Former German territories outside the borders of current-day Germany were excluded from the analysis (e.g., Silesia, Pomerania, East Prussia). For this macro-regional analysis, we took the raw data without any spatial interpolation procedures applied, as at this level of aggregation no major changes occurred in the borders that we use to distinguish the four macro-regions. The only exception is the Oder-Neisse border in the East, which generally does not correspond to the regional administrative borders that existed in the German Empire prior to 1945. This implies that our time trend for East Germany before 1945 did not cover the exact area that later became the German Democratic Republic. For example, we disregarded a small area of Silesia that today belongs to Saxony,

and the part of Pomerania that today belongs to Mecklenburg-Vorpommern. On the other hand, we included the population of the whole *Regierungsbezirk* of Frankfurt (Oder), which extended into present-day Poland.

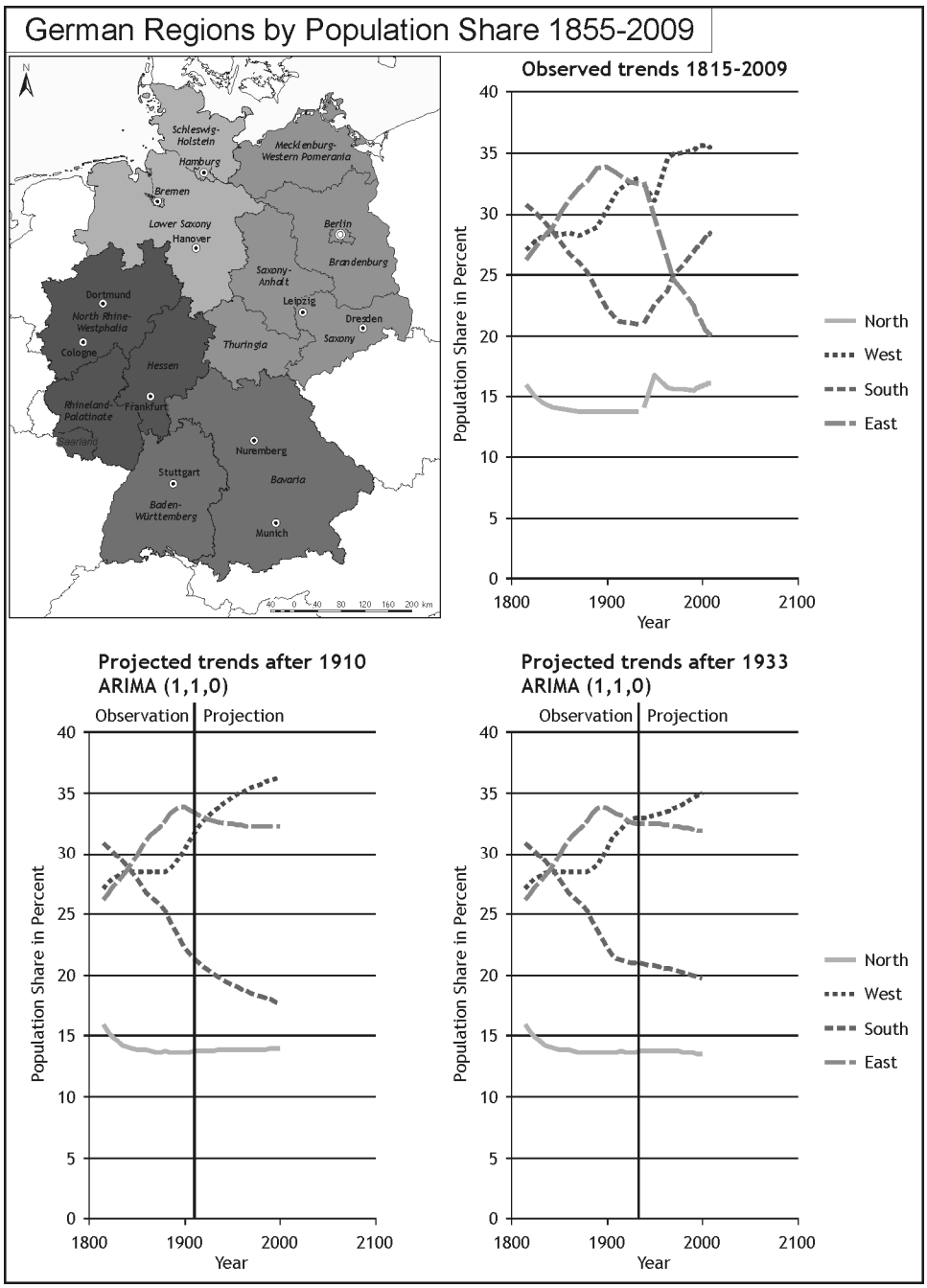

FIG. 2–The map in the upper-right corner shows the regional division used for the trend graphs. The latter show the observed and predicted trends at the cross-sections 1910 (last cross-section before World War I) and 1933 (last cross-section before Nazi rule/ World War II). In addition, it provides information on the location of important towns, which might be helpful for the interpretation of Figures 3, 4, and 5. *Source*: Statistical Offices, own calculations. *Base Map*: BKG (2009). (Cartography by author)

As Figure 2 illustrates, there is no level/trend change visible between the cross-sections 1933 and 1939, the points at which the break in the regional definition occurs. This assures us that the differences in the regional definition are negligible for our analysis. The values in the time series graph of Figure 2 are standardized and display the share that each of the four macro-regions contributed to the total population of all four macro-regions in a given cross-section.

Figure 2 shows that the share of the total population of Germany contributed by the North changed very little. The only exception was the period directly following World War II, when this area received a substantial number of refugees from the East. This influx compensated for losses in the North's population share in the early 19th century. Thus, at 16%, the North's current share of the total population is similar to its share in 1815. By contrast, the West has been able to increase its share from 27% to 35% over the last two centuries. We observed little changes in the direction of this trend, apart from the period 1939-1950, when this region experienced some population losses, probably as a result of the bomb attacks of World War II. The highest rates of increase were recorded in the periods 1890-1910 and 1950-1970.

The macro-regions that saw the most dramatic changes in population shares were the South and the East. In the early 1800s, the South contributed almost a third of the total population within the area of present-day Germany. But in the 19th century, the region's share declined sharply, to levels slightly above 20%. At that time, southern Germany offered only limited livelihood opportunities (Knodel 1967). Population density was quite high, but the region's landlocked position made it difficult for the South to keep pace with economic developments in the North, West, and East, which had better access to the rapidly developing global markets. The downward trend slowed after World War I, but did not reverse until after World War II. Since then, the population share of the South has increased again. However, at 28%, its share is still five percentage points below that of 1816.

Meanwhile, the East macro-region experienced trends that were almost the opposite of those in the South. In the 19th century, the population share of the East increased from 26% to 34%. But this upward trend stopped in the 1890s, when the population share of the East started to decline. This is inter-

esting for our research question, as the West saw the start of a rapid increase in its share around the same time, while the North and the South did not experience any changes in trend direction. However, the decline in the population share prior to 1945 was rather small, from 34% in 1890 to 32% in 1939. This decrease was minor compared to the losses experienced between 1939 and 2008, when the population share of eastern Germany fell to 20%.

To examine this issue more closely, we constructed for the four regions projections for the years 1910 and 1933 based on the trend data in the preceding periods. These years were selected in order to investigate how the population might have developed had World War I (1914-1918) and/or the Nazi period and World War II (1933-1945) not occurred. The results of these projections are shown in Figure 2. The projections of trends leading up to 1910 and 1933 both show a further decline in the share of eastern Germans among the total population of Germany. The projected values up to 1939 are very close to the observed figures, and confirm the observations made above. Large deviations between the projections and the observed trends are most apparent for the South, with the 1910 projection showing an additional sharp decline in the population share of this region that did not actually occur. The 1933 projection also showed that a further decline occurred, although at a slower pace. The dramatic changes in the trends in the South occurred around both World War I and World War II. This could suggest that the South benefited from the effects that these wars had on the spatial variation of conditions for population development in Germany.

We will now turn to the more finely gridded district data. Figure 3 gives an overview of the spatial differences in the population potential for the cross-sections 1855, 1939, and 2008. For these maps, we set b equal to one. Again, we exclude for the cross-sections before 1945 all German territories outside of the borders of current-day Germany. The color scheme of the maps in this figure, as well as in Figures 4 and 6, is based on a standard deviation categorization.

The population potential map of 1855 is a little bit misleading, as it gives the impression of an arc of population concentration stretching from the area around Frankfurt/Main in the West across Hessen, Thuringia into Saxony-Anhalt, and Saxony in the East. However, for this first cross-section

the pattern is sensitive to the value of the parameter b, as the spatial distribution was still rather homogenous compared to the later cross-sections. When we took a value of b equal to two, the map showed two separated centers of population concentration. One consisted of the Rhine-Ruhr area and the Rhine corridor in the West, which are part of the Blue Banana region. The other was situated in eastern Germany, with the center formed by the *Saxony Triangle* around Leipzig/Halle, Chemnitz/Zwickau, and Dresden.

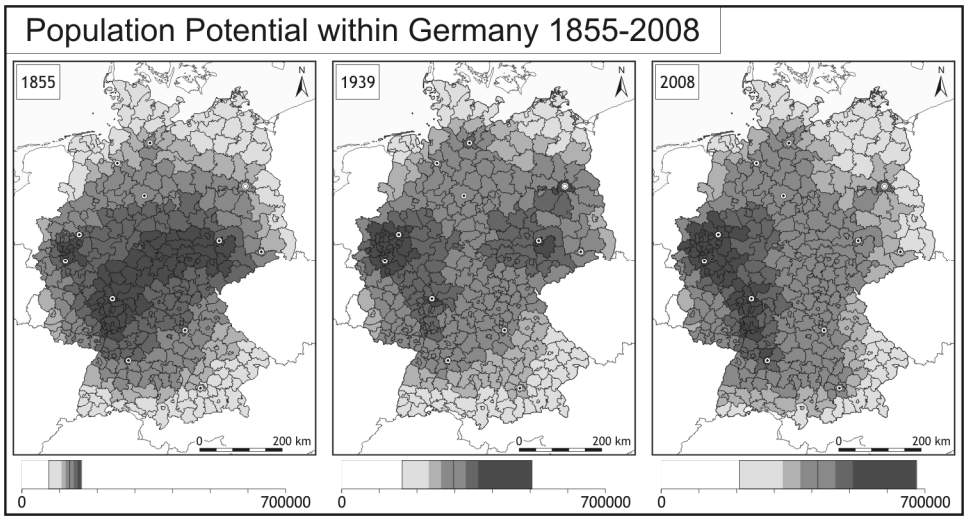

FIG. 3–Time-constant German 2008-districts; b=1. For city names, see Figure 2. *Source*: Statistical Offices, own calculations. *Base Map*: BKG (2009). (Cartography by author)

The emergence of these two population centers is likely attributable to the physical and economic geography of these areas. An important transport corridor in Central Europe, the Rhine valley has been a center of population concentration at least since Roman times. Saxony was positioned along an important Central European trade route that ran from the Netherlands in the West across Lower Saxony, Saxony, Silesia, and Lesser Poland into Galicia in the East. This trade route was situated in the transition zone between the lowland of the Middle European plain in the North and the adjacent mid-mountain ranges in the South. In the Saale ice age, the German part of this transition zone had been an accumulation zone of loess sediments, which offer very favorable conditions for the development of fertile soils. The *Börde* lands in this belt thus had the most fertile soils in Germany, which made them centers of agricultural production in the pre-industrial age. This probably had positive effects on population trends. Another important factor that fostered population

growth in these two areas in the proto-industrial era was their close proximity to important mineral deposits. The Ruhr area had coal deposits, while Saxony was positioned close to the Erzgebirge, where iron ore and other metals were extracted.

The second map of Figure 3 shows the population potential in 1939, the last census year before World War II and the division of Germany into a capitalist western part and a communist eastern part. The map of 1939 shows the bipolar pattern, which in 1855 was only visible if we increased the b-parameter. The Rhine-Ruhr area was an especially important center of population concentration, while the population densities of both Saxony and the Rhine-Main area around Frankfurt appeared to have declined relative to 1855. New centers with high population potential values had emerged around Berlin, the German capital, and Hamburg, the second-largest city in Germany and the country's most important harbor town.

The third map of Figure 3 shows the situation in 2008, the last cross-section in our analysis. Compared to 1939, eastern Germany had declined substantially as a population center within Germany. Only Berlin and some districts of Thuringia along the former German border had a population potential above the mean value obtained for all German districts. Hamburg maintained its position as the only area with above-average population potential in northern Germany, but lost population relative to other German regions. By contrast, the Rhine corridor in the West gained in importance. Compared to 1939, the area of high population concentration extended farther south towards the metropolitan areas around Frankfurt (Rhine-Main area), Mannheim/Ludwigshafen (Rhine-Neckar area), and Stuttgart. On this map, the Blue Banana arc is clearly visible as the area with the highest population concentration in Germany.

While the cross-sectional maps in Figure 3 are important for displaying long-term changes, maps showing changes in the population potential in different time periods can provide greater insight into how spatial trends develop over time. Thus, we will now turn to the change maps in Figure 4. Our reasons for choosing the cross-sectional years were explained above. In order to make the changes over time comparable, we standardized them so that the maps display average annual changes in the population potential between two cross-

sections. The first map in Figure 4 displays the changes between 1855 and 1885. In that period, eastern Germany was still the area with the largest increases in the population potential. These gains were concentrated in Saxony and the Berlin area. However, the average annual change rate was still rather low between 1855 and 1885 relative to the rate between 1885 and 1910. In the latter period, Saxony (especially Leipzig) and the Berlin area were still reporting above-average increases in population potential, but these areas were smaller relative to the changes reported in the Rhine corridor in the West. This trend of diminishing importance continued in the period 1910-1939.

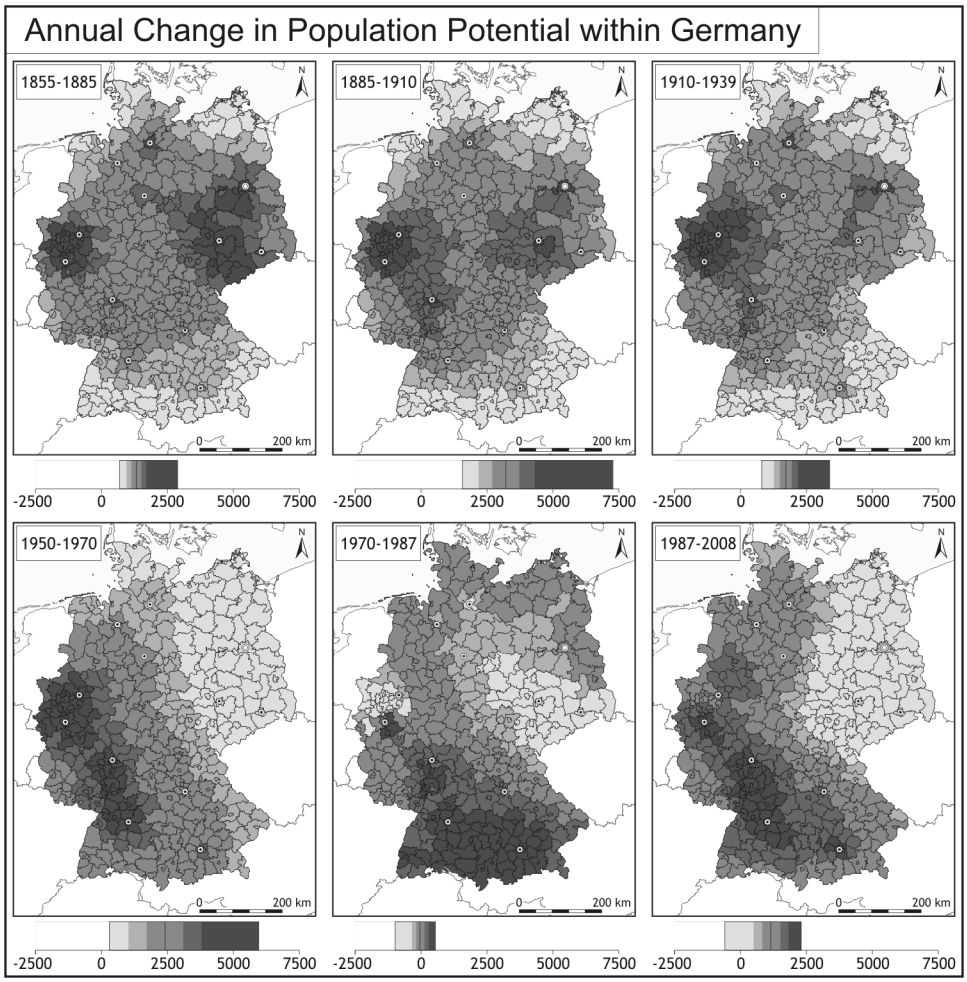

FIG. 4–Time-constant German 2008-districts; b=1. The World War II period 1939-1950 is not displayed, for city names, see Figure 2. *Source*: Statistical Offices, own calculations. *Base Map*: BKG (2009). (Cartography by author)

The observed pattern might be an indication of an early Blue Banana effect. Another factor might be spatial differences in the onset and intensity of the fertility decline, which started in Germany in 1890 and unfolded in a very

uneven pattern across the regions (see Knodel 1974; Goldstein and Klüsener 2010). Early centers of fertility decline were located in the area around Berlin and Saxony in eastern Germany, while Catholic rural areas in particular lagged behind. These latter areas were, with a few exceptions, all situated in the western part of Germany. To examine these trends in greater detail, we studied migration data for German states and provinces for that period (Besser 2008). Our investigation revealed that both the early fertility decline in the East and changes in the migration pattern played a role. The Prussian province of Rhineland in western Germany had experienced a negative migration balance between 1875-1885, which changed into a highly positive one in the period 1885-1933, before becoming negative again up to 1939. Saxony, on the other hand, had negative migration balances from 1900 onwards. This trend continued until 1939, with the exception of the period between 1925 and 1933.

The fluctuations in the migration regimes in the period after 1925 suggest that the East-West gradient in population development was unstable over the whole period between 1885 and 1939. This is also visible in a population potential change map of the period 1925-1939, which is not shown here. In this period, most of the population potential increases occurred in the corridor connecting the Ruhr area in western Germany via the Hanover region to Berlin in the East.

Due to space restrictions, we omitted the map displaying the development between 1939 and 1950. This is a very peculiar time period due to World War II, as many large German cities were the targets of heavy bombing. Many city residents fled to rural areas and only slowly returned to the cities after the war, as a large number of buildings were destroyed. In addition, this period saw substantial inflows of refugees from the former German territories east of the Oder-Neisse border. The areas around Hanover in Lower Saxony and northern Hessen benefited in particular from this trend, as they were located along the border of the Soviet Occupation Zone.

We will now turn to the fourth map, which shows the development between 1950 and 1970. In this period, the Rhine corridor and the Neckar area around Stuttgart in particular were experiencing the highest annual growth in population potential. In addition to a shift to the West, there also seems to have been a shift to the South, as for the first time in our analysis period the

area around Munich recorded an above-average increase in the population potential. Hamburg in the North, on the other hand, saw a decline in its population share after 1945. Redding and Sturm (2008) have argued that this may have been due to Hamburg's close proximity to the border of eastern Germany. Moreover, the city had traditionally played the important role of North Sea harbor for the eastern German territories, which were linked to Hamburg by the river Elbe. According to Redding and Sturm (2008), the development of the whole eastern border region of West Germany was negatively affected by the disruption of market linkages across the German-German border. As the population potential changes recorded in the territory of the German Democratic Republic were even smaller, an East-West gradient is clearly visible in the pattern.

In the period 1970-1987, the mean value of the changes in the population potential in the 413 districts is negative for the first time. The overall annual changes are very small compared to the numbers recorded in the preceding periods. In this phase, West Germany witnessed the emergence of a North-South gradient in spatial population development. The factors that are likely to have affected these trends were discussed above. Among the areas outside of southern Germany that continued to gain in population potential were the region around the West German capital of Bonn and the Rhine-Main area around Frankfurt/Main. In East Germany, the capital of East Berlin and the leading harbor town of Rostock were the regions that had the most favorable population potential trends. Saxony and Saxony-Anhalt were, on the other hand, the areas with the highest losses.

While minor changes occurred in the development of the population during the period 1970-1987, the situation looks very different again in the last map, which shows the changes that took place between 1987 and 2008. Most of these changes actually happened in the years immediately following the fall of the Iron Curtain in 1989, when Germany not only saw substantial internal migration between eastern and western Germany, but also high levels of in-migration from Eastern European states, such as Poland, Romania, Russia, and Ukraine. In the latter years of this period, the development of the population was again stagnant. Between 1987 and 2008, the Blue Banana zone benefited the most from increases in population potential. An exception was the Ruhr

area, with its structural economic problems. But the spatial pattern changed over time, as the Blue Banana zone benefited more than any other part of Germany in the immediate aftermath of the fall of the Berlin Wall. In more recent years, the centers of population growth have again moved to southern Germany (maps not shown here). In addition, the northern German harbor city of Hamburg has once again started to record above-average changes in population potential. While its position close to the German-German border had been a disadvantage during the period 1945-1990, the city seems now to benefit both from its location as an in-migration destination for migrants from eastern Germany, as well as from its position as a North Sea harbor for eastern Germany and Central Europe.

In general, the maps of Figure 4 show the substantial effects of the German division on spatial population trends in Germany. However, they also support the view that an East-West gradient in spatial population development was already visible prior to 1945. To examine this issue more closely, we produced a synthetic map for which we calculated the share of the total population contributed by each of the 413 districts that existed in 2008 in each of the cross-sections. In the maps of Figure 5, we display the cross-section in which the district contributed the highest share to the total population of Germany within a period of observation. The left map shows the total period 1855-2008, while the right map shows the calculations for the sub-period 1855-1939.

Many German districts did not experience strong urbanization trends. As a result, most recorded in the first cross-section of 1855 the highest share they contributed to the total population of Germany over the 150-year period. The left map for the total period 1855-2008 shows that in eastern Germany a number of districts registered above-average population increases in the period 1855-1885. This area encompasses an arc in northern Germany connecting Hamburg, Lübeck, and Rostock on the Baltic Sea, another arc stretching from the Harz mountains in the center of Germany across Saxony-Anhalt into Saxony, and a third area around Berlin. But the map also shows that these above-average increases came to an end in the late 19th and early 20th centuries, in line with the trends shown by the population potential maps. On the other hand, the shape of the Blue Banana is also visible on this map. This supports the view that the Rhine corridor, together with extensions of this corridor

across Stuttgart to Munich and to the northwest in the direction of Hamburg, continue to be relevant for spatial population trends in Germany.

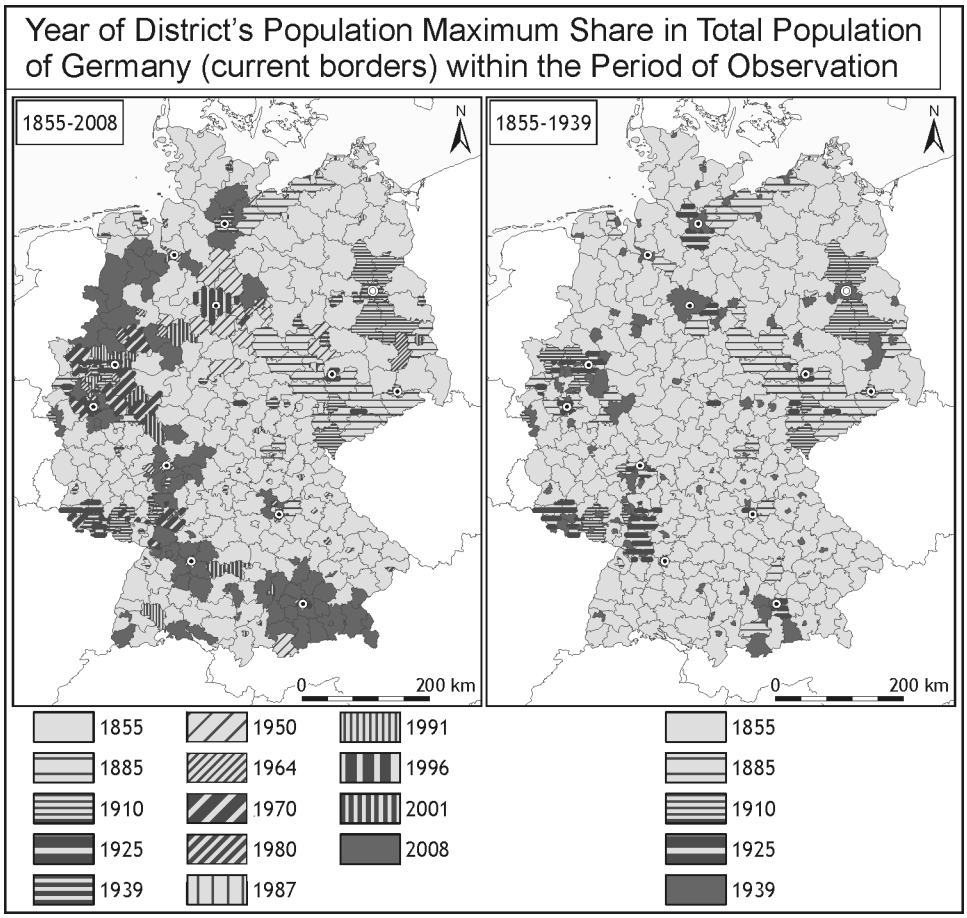

FIG. 5–Time-constant German 2008-districts. For city names, see Figure 2. *Source*: Statistical Offices, own calculations. *Base Map*: BKG (2009). (Cartography by author)

However, the map on the right hand side shows no indication of the emergence of the Blue Banana zone as an important area of population concentration prior to 1945. Indeed, quite a number of cities/areas in the Blue Banana zone experienced a reversal in earlier trends during this period. This includes cities in the Rhine-Ruhr area, such as Cologne and Dortmund.

The assumption that the Blue Banana area of Germany did not become a focal point of population development until after the war is also supported by Figure 6, which shows changes in the population potential on a European scale. In the period 1870-1930, all of Central Europe was experiencing above-average increases in population potential, including areas such as present-day

western Poland and Czechoslovakia. Population development was centered on the Blue Banana area only during the period 1930-2008.

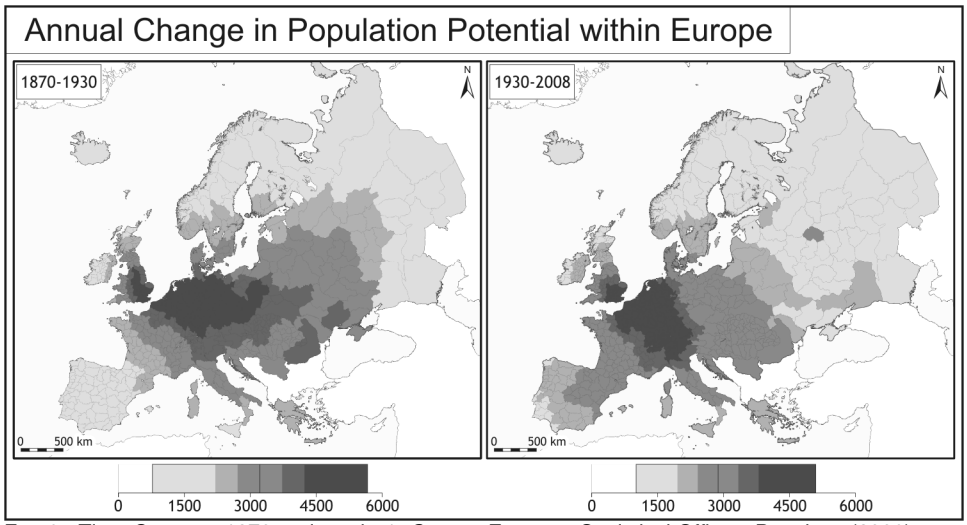

FIG. 6– Time-Constant 1870-regions; b=1. *Source*: Eurostat, Statistical Offices, Populstat (2006), own calculations. *Base Map*: MPIDR & CGG; partly based on © EuroGeographics for the administrative boundaries. (Cartography by author)

Discussion and Conclusion

Our analysis showed that eastern Germany had started to fall behind Germany's average population growth rates as early as in the late 19th century. During this time, the central part of western Germany entered a period of strong population increase. This lends support to our argument that, in addition to the recent legacy of the GDR, other factors have contributed to the emergence of an East-West gradient in Germany's spatial population development. However, prior to 1945, the decline in eastern Germany's importance as a population center was small compared to the trends observed during and immediately after the GDR period, which had tremendous effects on population developments.

The results were less conclusive for our second hypothesis; namely, that the East-West gradient in population development can be linked to European integration effects. We expected to find that these effects contributed to population increases in the part of western Germany situated within the Blue Banana zone (see Figure 1). Although western Germany experienced strong population increases before 1945, the Blue Banana zone did not register above-average population increases in this period. This drastically changed

after 1945, as the Blue Banana zone saw large increases in the 1950s and 1960s, as well as in the period following the unification of Germany in 1990. One explanation for this development might be a reverse causality effect in which the Cold War and the division of Germany fostered additional population concentration in the Blue Banana zone, as it was the part of Germany located the farthest away from the German-German border. Its location is likely the reason why the zone suffered less from the market disintegration effects that occurred as a result of the German division (Redding and Sturm 2008). The West German capital of Bonn was also located in this Blue Banana area, which probably created some additional growth effects. Overall, it is likely that a mixture of disintegration effects towards the East as well as integration effects towards the West made the Blue Banana zone such an important area of population concentration within Germany.

Our findings show that the development of population distribution in Germany can be explained both by the persistence of long-term trends, as well as by more recent historical events. Although historical accidents are hard to predict, long-term trends show important regularities. Quantifying the persistence of longstanding trends is an extremely important task, because it helps us to understand the role of macro factors, such as international integration, on population distribution. In addition, evaluating the persistence of long-term trends is relevant as we seek to improve forecasts of future population development.

Endnotes

[1] The maps used in this publication are partly based on the following sources:
© EuroGeographics for the administrative boundaries.
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[2] The relationship between cohort size and economic opportunities in Germany has been discussed extensively by presenters at the workshop "The 'Lucky Few'? How shrinking cohort size affects life-course chances", Max Planck Institute for Demographic Research, October 4 and 5, 2011.

[3] In the German Reich statistics these were called "smaller administrative areas" (*kleinere Verwaltungsbezirke*). Regarding the size of such units, there was no common standard that existed across the states of the German Empire. Especially problematic was the situa-

tion in the states of Mecklenburg-Schwerin and Mecklenburg-Strelitz, which had, until the 1920s, feudal administration structures. The two states were divided into dozens of small territories with a large number of enclaves and exclaves. But we benefit from the fact that the statistical office of the German Empire dealt with these comparability problems by constructing so-called statistical areas for problematic territories like the two states in Mecklenburg. The statistical areas that were formed by the statisticians were similar in size to the Prussian districts.

[4] The data prior to the census 1834 have to be interpreted with special care, as the enumeration standards were not harmonized in the German Empire prior to this year (Michel, 1985, p. 82).

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