The East-West Gradient in Spatial Population Development Within Germany
Temporary GDR Legacy Versus Longstanding Spatial Disparities

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Abstract. Since Germany’s unification in 1990, the former communist eastern part has experienced substantial out-migration toward western Germany. This article explores whether this is predominantly a temporary phenomenon related to the post-communist transition crisis, or whether longstanding geographic disparities in economic development also play a role. In particular, we are interested in whether long-term trends are shaped by the fact that parts of western Germany belong to the so-called European dorsal that has long been the most important center of economic activity in Europe. We address the question by investigating spatial population trends over the last two centuries. Findings suggest that longstanding geographical disparities are relevant. However, prior to 1945, population concentration in western Germany was not focused on the European dorsal region.

Keywords: European integration, German Division, Germany, population development, spatial analysis

Past and Present Spatial Disparities in Livelihood Opportunities in Germany

Over the last 20 years, East-West differences in livelihood opportunities and the East-West migration patterns that resulted from these disparities 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 eastern Germany. Demographic factors have also influenced these changes in migration trends. 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. Thus, as the legacy of the GDR fades, we might expect a new paradigm in spatial population trends to 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 can also benefit from its traditional emphasis on education and its high density of universities. These North-South differences in economic development prevail until today and may gain prominence in spatial population trends again as the period of high structural unemployment levels in the East seems to come to an end.

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 already before 1945 (Kirsten, Buchholz, and...
Köllmann 1966). A longstanding factor that may have influenced these trends is the proximity of western Germany to important European centers of economic activity. Roger Brunet (1989) has pointed out that parts of southwestern and 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). As European integration goes on, this area might continue to benefit substantially from spillover effects of this process. If this were the case, we might expect East-West differences in economic development to prevail within Germany and trends of increasing population concentration in western Germany to continue.

We believe that a historic analysis of spatial population trends in Germany over the last two centuries might improve our understanding of likelihood of alternative future scenarios. Related to this, it is important to see that Central Europe was, during the twentieth century, heavily affected by war and the movement of refugees, as well as by a period of tight border regimes during the Cold War. Thus, spatial population trends over the last 100 years have been heavily influenced by these events and might not be very informative for predicting future population trends in Central Europe. As a matter of fact, Central Europe is today characterized by low limitations in the movement of people. We argue that the study of historical periods is particularly important to evaluate the relevance of longstanding spatial disparities for spatial population trends. More specifically, it might be very instructive to study trends during the period before World War I, in which Central Europe was also characterized by low restrictions on the freedom of movement.

Although Germany has a long history of significant internal migration trends (Mai 2007), it is striking that no efforts have been made to assess tendencies in spatial population trends in a quantitative and systematic manner for this country over the last two centuries. One obstacle in such an endeavor is that Germany has experienced frequent changes in the internal administrative boundaries of regions for which population data are available. In particular, before 1945 there has hardly been any single year in which not at least one of the German states implemented changes in their internal administrative division. These discontinuities in the regional setup pose a challenge in the analysis of long-term population trends. In this article, we make use of a newly compiled time-variant GIS database of changing administrative district and regional boundaries in Germany over the last 200 years (MPIDR 2014). This new GIS data allows us to overcome longstanding obstacles related to data availability for Germany. It thus enables us to assess for the first time in a systematic manner long-term spatial population trends in Germany in fine geographic detail.

Based on the above considerations, we identify two main research goals. The first one is to give a descriptive account of spatial population trends in Germany over the last 200 years. With this line of research, we are complementing existing studies about Europe in broader geographic detail (Gregory, Martí-Henneberg, and Tapiador 2010) and those with finer geographical detail that focus on specific parts of Europe (e.g., Silveira et al. 2013 on the Iberian Peninsula). We aim to improve our understanding of the factors that affected spatial population development at specific times and to identify time periods in which there were substantial changes in trend patterns. The second research goal is to explore the role of longstanding spatial disparities in influencing spatial population trends in Germany. If the East-West gradient in Germany’s spatial population development over the last two decades can primarily be explained by the recent legacy of the German Democratic Republic (GDR), we would expect the population agglomeration in western Germany not to be particularly focused on the Blue Banana zone. If, however, in addition to this, the location of parts of western Germany in the Blue Banana zone also affects the trends, we might expect population concentration over the last 20 years to substantially increase in this area. Moreover, we might also detect similar trends in historical periods with low restrictions in the movement of people (e.g., in the one prior to the start of World War I in 1914).

Theoretically, our study is based on the work of Gunnar Myrdal (1957), Friedrich Buttler, Knut Gerlach, and Peter

**FIGURE 1. Population density in Europe 2008.**

*Note:* Blue Banana zone is indicated by the dotted-lined area.

*Source:* Eurostat, Statistical Offices, own calculations.

*Base map:* MPIDR (2014); partly based on © EuroGeographics for the administrative boundaries.
Liepmann (1977), and Paul 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 spillover effects in the centers of economic activity and selective migration of highly qualified people into those regions (see also Greenwood 1975).

However, pure economic theories would probably fall short of explaining the observed spatial pattern of population change. Migratory decisions, which are currently the main cause of regional disparities in Germany’s 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 may contribute to our understanding of why it is the case 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 we predominantly derived from official statistical publications of Germany, the German Democratic Republic, the German Empire, and from publications of member states of these entities. Only for our earliest cross section of district-level data (1855) we used data from a secondary source (Viebahn 1858). We sought to collect 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.

In order to link the population data to spatial locations, we make use of our new historical GIS of administrative boundaries of Germany which we make available for scientific use as part of the MPIDR Population History GIS Collection (MPIDR 2014). 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 is available from 1871 onward, while for the period 1815–71, 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. Our historical GIS shapefiles of European administrative borders we also make available for scientific use as part of the MPIDR Population History GIS Collection (MPIDR 2014). They are partly based on a 2003 shapefile of the administrative boundaries of Europe from EuroGeographics (2006).

We were able to obtain and digitize district-level population data for Germany for the following cross sections: 1855, 1885, 1910, 1925, 1939, 1950, 1964, 1970, 1980, 1987, 1991, 1996, 2001, and 2012. The earliest cross section of 1855 comprises results of a census from a period prior to the unification of Germany in 1871. 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. Data from 1910 were collected in the last census 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, while the census of 1939 was the last conducted 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 1981 in East Germany and in 1987 in West Germany. The years 1991, 1996, and 2001 are the only cross sections in our observation period that are not close to any preceding countrywide censuses. This is because between the censuses of 1981 (East Germany) and 1987 (West Germany) and the recent enumeration of 2011, no population censuses were carried out in Germany. These three 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. As the last cross section we took 2012, as this is the year for which the most recent data are available. These data are already based on the results of the 2011 census, which was for the first time not a complete census, but a register-based
one. Future research will show whether the results obtained by this more cost-efficient approach are of similar quality as the outcomes of a complete census (see, e.g., reflections by Coleman 2012).

In addition to the time series at the district level, we also obtained a longer time series for the states and provinces of Germany 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 1816–1933, based on the administrative division that existed in 1934. From 1939 onward, we used data published by the Statistical Offices of East Germany and (West) Germany, which included retrospective estimates of population numbers for 1939 for the administrative division that existed after the war. These data allow us to study large scale spatial population trends from the end of the Napoleonic period onward and will also be used for our regional projections based on historical trends. For our analysis of population changes in the European regions, we obtained data for the cross sections 1870, 1930, and 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 402 in 2012. 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 the modifiable areal unit problem (Openshaw 1984). We therefore decided to apply an estimation procedure to obtain a dataset with regions of time-constant area for the period 1855–2012.

In order to derive the dataset for our analysis, we used an areal interpolation procedure based on area 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 in a given census year. 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 not interested in the micro dimensions of spatial population development, which implies 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 considered it not necessary to use more complex estimation methods, such as the EM algorithm (see Gregory 2002).

We also had to take a decision for which so-called target regions with time-constant areas we wanted to derive population estimates. For this, we chose the German district division of 2008. Our motivation to not use the division in 2012 was that we did not want to account for the recent administrative reform in the northeastern German state of Mecklenburg-Western Pomerania. This reform reduced the number of districts in northeastern Germany substantially and created districts which are in terms of the area unusually big for German standards. Thus, we felt the 2008 division would be better suited for our research aim to look at small scale aspects of spatial population changes in Germany. For Europe, we must 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.

In order to derive the estimates, we intersected a GIS polygon file with border and area information on the source regions with the polygon file of the target regions of time-constant area. We thus obtained a GIS dataset with the smallest common polygons. This allows us to compute 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 and \(y_s\) are the population counts reported in the source regions. \(A_s\) is the area of the source region, and \(A_{st}\) denotes the area of the zone where the source and target regions or respectively polygons intersect (Goodchild and Lam 1980).

Methods

Our analysis consists of descriptive statistics, cartographic representations, and projections based on historical trends. We already mentioned that one of the main challenges we faced was the allocation of people to time-constant areas. The dataset we generated by areal interpolation is biased at small scales (for a detailed discussion, see Gregory 2002). To address this problem, we used a spatial smoothing technique, which smoothes out small-scale fluctuations. As a result, we obtained a dataset that is appropriate to study variation at the geographic scales that are of relevance for our analysis. 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:

\[ V_i = \sum_{j=1}^{n} \frac{P_{ij}}{D_{ij}^b}, \]

where \( V_i \) is the population potential of district \( i \); \( P_{ij} \) denotes the total population in district \( i \) and any other district \( j \) in the sample; and \( D_{ij} \) is the spatial distance between the geographic centers 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, \( D_m \), as \( D \) must be bigger than 0. This is derived using the following equation:

\[ D_m = \sqrt{\frac{\sum_{i=1}^{n} A_i}{n * \pi}}, \]

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 (or Europe in the case of the European maps) 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. ARIMA models represent a standard and flexible statistical tool in time series analysis. They are typically used to get insights about trends in historical data or to make forecasts. The underlying idea is that the evolution of a variable over time is informative to make predictions of future trends. A detailed description of ARIMA models is beyond the scope of this article. A full treatment of these models can be found in standard textbooks of time series analysis (e.g., Brockwell and Davis 2002). These and related models have been widely used in demographic forecasting. For an extensive review of forecasting methods in demography, see Heather Booth (2006).

Our model selection procedure produced qualitative results similar to a choice of ARIMA (1, 1, 0), which implies that the differences in the time series were regressed against the differences one period before. In other words, in qualitative terms, the model that we selected extrapolates linear trends into the future. This is consistent with a class of demographic models that generate projections based partially on linear extrapolations (see, e.g., Myrskylä, Goldstein, and Chen 2013).

**Long-Term Trends in the Spatial Population Distribution in Germany**

Before turning to the analysis of our district-level data, we will first look at the macro-regional, long-term population trends since 1816. 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, large parts of Pomerania, and 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 used 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 data for East Germany before 1939 does 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-Western Pomerania. On the other hand, we included the population of the whole Regierungsbezirk of Frankfurt (Oder) in Brandenburg, which extended into present-day Poland. As Figure 2 illustrates, there is no level/trend change visible between the years 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 Germany (in its current borders) in a given year.

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 nineteenth century. Thus, at 16%, the North’s current share of the total population is similar to its share in 1816. By contrast, the region 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 1939–50. The highest rates of increase were recorded in the periods 1890–1910 and 1950–70.

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. However,
in the nineteenth 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 around 29%, its share is still two 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 nineteenth century, the population share of the East increased from 26% to close to 34%. However, this upward trend stopped in the 1890s, when the population share of the East started to decline. This is relevant for our interest in the origins of the East-West gradient of population trends in Germany, as the West saw the start of a rapid increase in its population share around the same time, while the North and the South did not experience any changes in trend direction. However, the decline in Eastern Germany’s population share prior to 1945 was rather small, from 34% in 1890 to 32% in 1939. This decrease was minor compared to the losses between 1939 and 2012, when the population share of eastern Germany fell below 20%.

To examine this issue more closely, we constructed for the four regions population projections for the years 1910 and 1933 based on the population trend data in the preceding periods. These years were selected in order to explore how the population might have developed had World War I (1914–18) and/or the Nazi period and World War II (1933–45) not occurred. The results are shown in Figure 2. The projections based on 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 suggested that a further decline would happen, 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 analysis of 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 2012. For these maps, we tested different specifications for the parameter \( b \) in our population potential equation. We finally decided to set it equal to one as this provided a good compromise between the interest to smooth out small-scale noise and the goal to be able to identify developments particularly in the Blue Banana region. Again, we exclude for the cross sections before 1945 all German territories outside 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 centered on the mean.

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 very sensitive to the value of our smoothing parameter \( b \), as the spatial distribution of the population was still rather homogenous compared to the later cross sections. When we took a value of \( b=2 \), 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 between Leipzig/Halle, Chemnitz/Zwickau, and Dresden.

The emergence of these two population centers is likely attributable to the physical and economic geography of these areas. As 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 so-called Börde lands in this belt thus had the most fertile soils in Germany, which made them centers of agricultural production in the preindustrial 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 exhibits 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 relevance of both Saxony and the Rhine-Main area around Frankfurt as German population centers 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 displays the situation in 2012, the last cross section in our analysis. Compared to 1939, eastern Germany had declined substantially as a population center within Germany. Only Berlin, Potsdam, 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 importance 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 toward 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 transformations, 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 and the Berlin area were still reporting above average increases in population potential, but these were smaller relative to the growth reported in the Rhine corridor in the West. This trend of diminishing importance of eastern Germany continued in the period 1910–39.

The observed pattern could 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 2014). 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 present-day 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 from 1875–85, 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 onward. This trend continued until 1939, with the exception of the period 1925–33.

The fluctuations in the migration pattern in the period after 1925 suggest that the East-West gradient in population development was not stable over the whole period between 1885 and 1939. This is also visible in a population potential change map of the period 1925–39, which is not shown here. In this period, most of the population potential increases occurred in a corridor covering regions both in eastern and western Germany (from the Ruhr area in the West via Hanover region to Berlin in the East).

In order to save space, we omitted the map displaying the development between 1939 and 1950. This is a very
peculiar time period due to World War II, as virtually all 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 western 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 Blue Banana zone with the Rhine corridor and its extensions into the Neckar area around Stuttgart was 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 study 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 potential after 1945. Stephen J. Redding and Daniel M. Sturm (2008) have argued that this may have been due to Hamburg’s close proximity to the GDR border. 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 Elbe River. 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 1970–87, 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.

FIGURE 4. Annual change in population potential within Germany.

Note: Time-constant German 2008 districts; $b = 1$. The World War II period 1939–50 is not displayed. For city names, see Figure 2.

Source: Statistical Offices, own calculations. Base map: BKG (2009).
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 1970–87, the situation looks very different again in the last map, which shows the changes that took place between 1987 and 2012. 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 immigration from Eastern European countries. In the middle of this period, the development of the population was rather stagnant, before in-migration streams again increased in the most recent years. Between 1987 and 2012, the Blue Banana zone benefited the most from increases in population potential. An exception was the Ruhr area, with its structural economic problems. However, 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 the last 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 returned to register above-average changes in population potential. While its position close to the German-German border had been a disadvantage during the period 1945–90 (Redding and Sturm 2008), 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 synthetic maps 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 specific period of observation. The left map presents the total period 1855–2012, while the right map presents 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 period of analysis. The left map for the total period 1855–2012 shows that in eastern Germany a number of districts registered above-average population increases in the period 1855–85. 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. The map also shows that these above-average increases came to an end in the late nineteenth and early twentieth 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 northeast in the direction of Hamburg, continue to be relevant for spatial population agglomeration trends in Germany.

However, the map on the right 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 an end of earlier above average population increases 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 World War II 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 which constitute today western Poland, the Czech Republic, and Slovakia. Population development was centered on the Blue Banana area only during the period 1930–2008.

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 nineteenth century. During this time, the western 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 more longstanding factors have also 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 hypothesis that the East-West gradient in population development can be linked to European integration effects. We expected to find
FIGURE 5. Year of district’s population maximum share in total population of Germany (current borders) within specific periods of observation.  
Note: Time-constant German 2008 districts. For city names, see Figure 2.  
Source: Statistical Offices, own calculations. Base map: BKG (2009).

FIGURE 6. Annual change in population potential within Europe.  
Note: Time-constant 1870 regions; $b = 1$.  
Source: Eurostat, Statistical Offices, Populstat (2006), own calculations. Base map: MPIDR (2014); partly based on © EuroGeographics for the administrative boundaries.
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 above-average population growth before 1945, population concentration was not centered on the Blue Banana zone. 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 toward the East as well as integration effects toward the West made the Blue Banana zone such an important area of population concentration within Germany in the twentieth century.

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 disparities 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.

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NOTES

1. The maps used in this publication are partly based on the following sources: © EuroGeographics for the administrative boundaries and © Bundesamt für Kartographie und Geodäsie, Frankfurt am Main, 2009—reproduction, dissemination, and public display, also in parts, for non-commercial use permitted.

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 Verwaltungsbereiche). Regarding the size of such units, there was no common standard that existed across the states of the German Empire. Especially peculiar was the situation 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. However, we benefit from the fact that the German Imperial Statistical Office 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 used by the statisticians were similar in size to the Prussian districts.

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

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